Mr. Martin Miller
P.I. Management Office, TFL
NASA Johnson Manned Spacecraft Center
Houston, Texas 77058

MINERAL EXPLORATION AND GEOLOGY

APPLICATIONS OF ERTS-1, EREP, AND RB-57F

IMAGERY AND PHOTOGRAPHY OF THE UTAH - NEVADA AREA

June 14, 1974

By

Professor Mead LeRoy Jensen
Department of Geology and Geophysics
University of Utah
Salt Lake City, Utah 84115

Assisted By

Philip Laylander
500 East 4800 South
Salt Lake City, Utah 84107

Submitted to:

Mr. Martin Miller
P.I. Management Office, TFL
NASA Johnson Manned Spacecraft Center
Houston, Texas 77058

Mineral Exploration and Geology
Applications of ERTS-1, EREP, and RB-57F
Imagery and Photography of the Utah - Nevada Area

June 14, 1974

By: Professor Mead LeRoy Jensen
Department of Geology and Geophysics
University of Utah
Salt Lake City, Utah 84112
Contract No. NAS9-13322

Assisted by:
Phillip Laylander
500 East 4800 South
Salt Lake City, Utah 84107

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle: Folio of ERTS-1, EREP, and RB-57 imagery applied to Geology and Mineral Exploration in Utah and Nevada		5. Report Date 6. Performing Organization Code
7. Author(s): M. L. Jensen and P. A. Laylander		8. Performing Organization Report No.
9. Performing Organization Name and Address Department of Geology and Geophysics University of Utah Salt Lake City, Utah 84112		10. Work Unit No. 11. Contract or Grant No. NAS9-13322
12. Sponsoring Agency Name and Address NASA Johnson Manned Spacecraft Center Houston, Texas 77058		13. Type of Report and Period Covered Type I. Progress Report May 1 - July 31, 1974 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This folio of 53 pages includes 41 enlargements of ERTS-1, EREP (S-190 A&B), and RB-57 color and B&W images of specific areas of Utah and Nevada. Color geologic and aeromagnetic maps are included and correlated by scale to specific images. The areas included are: (1) solar evaporation ponds, Western Salt Flats, Utah; (2) San Rafael Swell with transparent geologic overlays, Utah; (3) Bingham Porphyry Copper Deposit with one image enlarged to 1/19,200 (S-190-B), Utah; (4) Cedar Mountain that includes an RB-57 color photograph at a scale of 1/200,000, and a low-level color airphoto at a scale of 1/6,000; (5) Tonopah-Goldfield area with color enlargement (S-190-B) of Goldfield area of hydrothermal alteration at a scale of 1/87,000; (6) Robinson Mining District and Ruth Porphyry Copper deposit, Nevada; (7) and the Lisbon Anticline area and La Sal Mountains, Utah.

The images in color and B&W at different scales illustrate the comparative utilizations of Space Imagery to Geology and Mineral Exploration.

17. Key Words (Selected by Author(s))	18. Distribution Statement
Geology Mineral Exploration Mapping Image Enhancement Scale	Martin Miller, P.I. Management Office, TFL - NASA Johnson Manned Spacecraft Center National Technical Information Center

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
		53	

*For sale by the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

Figure 2. Technical Report Standard Title Page

This requested report indicates some of the applications of space imagery to geological and associated subjects. The areas included are selected parts of Utah and Nevada where various low level color photographs, RB-57F, ERTS-1, and EREP imagery and photographs are available, have been studied, and some of which are included in this report.

The main objective of these studies is applied to mineral exploration and geological studies.

The thesis is that major ore targets may be located effectively and economically in a large complex region by sophisticated analysis of multispectral earth satellite photography. Detailed analysis of the selected ore targets requires RB-57F, or comparable high resolution photography. ("Major ore target" in this context is a composite rock-structure-alteration-mineralization feature from one to ten square miles area comparable to known major ore districts and deposits.) This estimate is based upon 18 months intensive analysis and evaluation of ERTS-1, S-190A/B, and RB-57F multispectral photography of Nevada and Utah, and parts of surrounding states.

Optimum quality photographic enlargements of the S-190B multispectral photography can be used to map large faults, fractures, and lithologic units, but their most important use at this time from an economic standpoint, is for recognition of those composite rock-structure-alteration-mineralization "anomalies" characteristic of major ore deposits. It appears that systematic exploration for major ore targets in a large favorable region -- 250,000 to 1,000,000 square miles with S-190A/B multispectral photography can be accomplished perhaps five times as rapidly at one fifth of the cost of conventional methods. High quality 1:1,000,000 and 1:250,000 scale enlargements show many large geologic features genetically related to major ore deposits which could not be seen in the field, on geologic maps, or with larger scale aerial photography. ERTS-1 data is important at this time for providing information on those areas not covered with S-190A/B photography and in those areas where structural features, seasonal variations, varying sun angles, etc. are provided by ERTS-1 imagery.

The extent to which high resolution (S-190A/B) space-acquired data can be utilized for mapping faults, fracture patterns and lithology for location of potential economic mineral deposits is best provided at this time by providing color enlargements of the photography and geologic maps of areas with a variety of geologic details and patterns. Each photograph (and related geologic map) displays only a small part of a region. However, individual photographs covering 10,000 square mile blocks (or 250 square mile parts) show that most major ore deposits are recognizable as rather distinctive areas, and that several of the significant geologic units can be identified. This report was put together in a few days time utilizing simple inexpensive photographic procedures to provide an introduction to materials and methods used, and a summary of results obtained in an intensive 18 month's study.

Some of the general observations concerning the use of the multispectral earth satellite photography and RB-57F high altitude multispectral photography are as follows:

1. B & W and Infrared color photographs provide limited additional geologic data in addition to the normal color. However, more refined structural detail in a target area provided by the B & W photograph combined with a color anomaly provided by the IR color photography does assist in recognition of a major ore target not apparent on the normal color photograph.
2. S-190A/B and ERTS-1 provide an effective screening method, as only large ore targets can be identified effectively on the 1:250,000 to 1:1,000,000 scale enlargements. Broad hydrothermal alteration zones in which relatively small vein deposits may occur can be identified.
3. Enlargements of the RB-57F photography at a scale of 1:10,000 provide fine detail permiting study of essentially all of the significant composite rock-structure-alteration-mineralization features required for recognition of specific mineral objectives. Detailed planning of field geological,

geochemical, and geophysical work can be made with such large scale data and such imagery can be used as a base map.

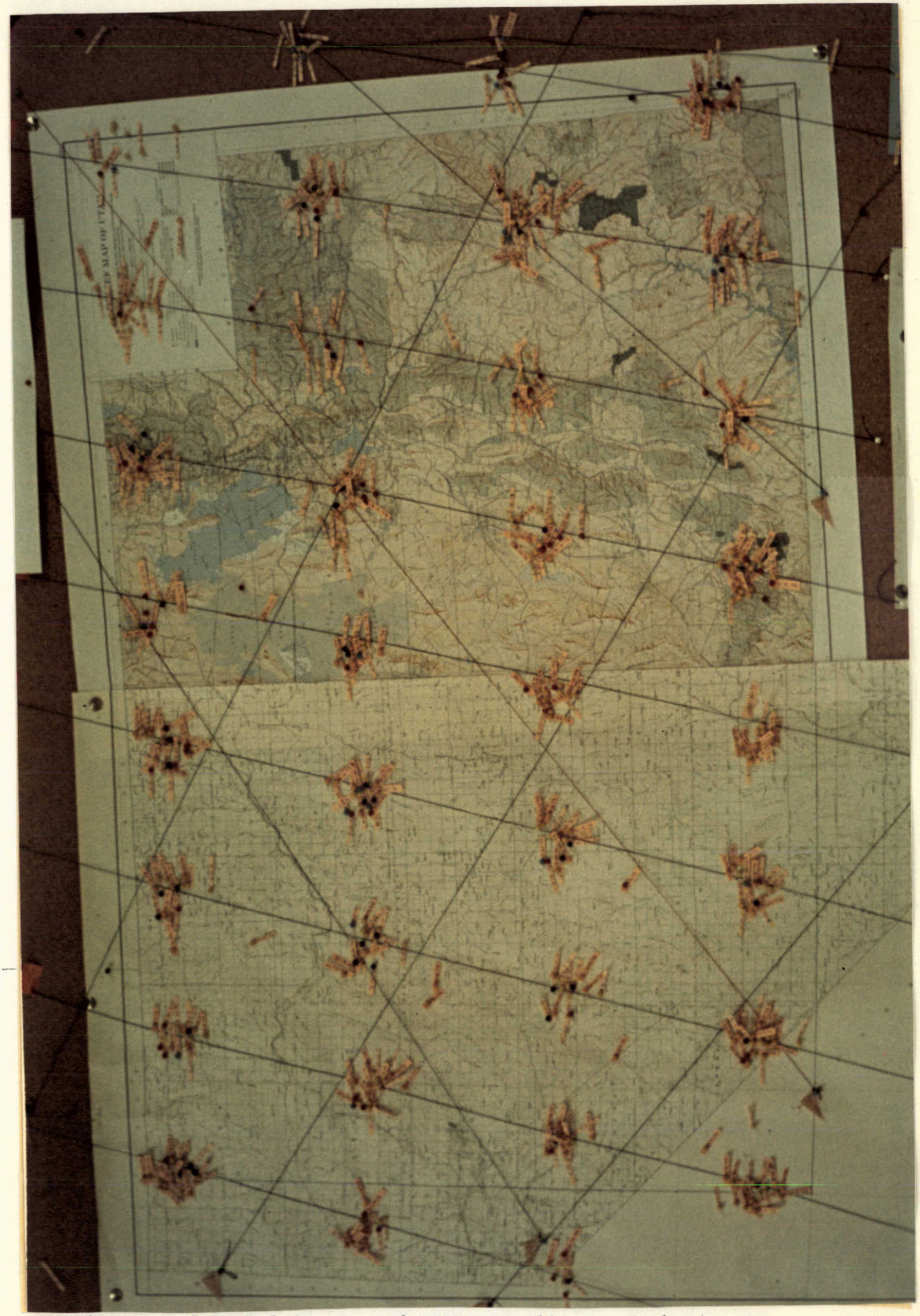
4. S-190B high resolution color photography is particularly valuable since it provides approximately ten times the detail of the S-190A photography and can provide sufficient detail even on 1:50,000 scale enlargements for analysis and evaluation of most of the significant geologic features on major ore targets.
5. Stereoscopic study of the S-190A/B photographs often provides several times the structural detail obtained by non-stereoscopic study, and color (compared to B & W) provide several times the key lithologic data required for recognition of hydrothermal ore deposits, rock alterations and gossans and weathered ore outcrops or alluvium derived therefrom.
6. Recognition of potential ore targets from multispectral earth satellite photography is aided by extensive prior color photogeologic and field geologic exploration in a region, and by consideration of results of current research in regional tectonics and magmatism related to ore genesis.
7. Optimum quality enlargements of the multispectral earth satellite photography are required for effective recognition of specific ore targets. New photographic materials and processes provide ten times the detail and acutance formerly available. Color balance, saturation, density, and contrast can be tailored to optimize the view of selected areas -- providing the original photographic duplicate color positive or negative transparency is of optimum quality.

Summary of Maps, Photographs, and Images of Areas
Included in This Report:

1. The photographic reproductions were made with simple inexpensive photographic and processing equipment. With more expensive equipment increased detail and sharpness should be obtained.
2. The geologic map sections were made from 1:250,000 scale State and County maps. A ruler is included in the copies to indicate the reproduction scale: 1" on ruler = 4 miles. (Color reproductions of geologic maps were delayed at printer. B & W reproductions are not as readable as the color prints but color prints will be provided in the next week.
3. The photographic reproductions for the several areas were organized to show correlation value of various images used for geologic analysis. Each type (B & W or color) and each scale 1:5,000 to 1:1,000,000 provides a different set of geologic data. Systematic exploration for major deposits would normally use all types in a coordinated analysis.
4. From East to West the areas covered are:
   a. LaSal Mts. and surrounding uranium districts: Enlargements of Lisbon Anticline.
   b. San Rafael Swell, Emery County, Utah. Enlargements of south part to show fracture and erosion patterns and ease of geologic mapping on S-190B enlargements.
   c. West central Utah. Various enlargements of Bingham Copper Mine area showing details of geologic formations, alteration and pit operations.
   d. Western Utah. Enlargements of Bonneville Salt Flats and detailed solar evaporation tanks.
   e. East central Nevada. Enlargement of Ely Copper District and area to north where erosion of Tertiary volcanics has exposed underlying Permian limestone and aeromagnetic maps still show anomalies where magnetic volcanics have been removed.

f. West Central Nevada. Enlargements of Cedar Mts. (east edge of Mineral County) enlargements of southern part are a prime example of geologic detail variations of imagery of different scales.

g. Western Nevada. Enlargements of Goldfield - Tonopah Area NE part of Esmeralda County. This is a classic hydrothermally altered area with the oxidized and hydrothermally alteration volcanics exhibiting the classic various ocherous colors.



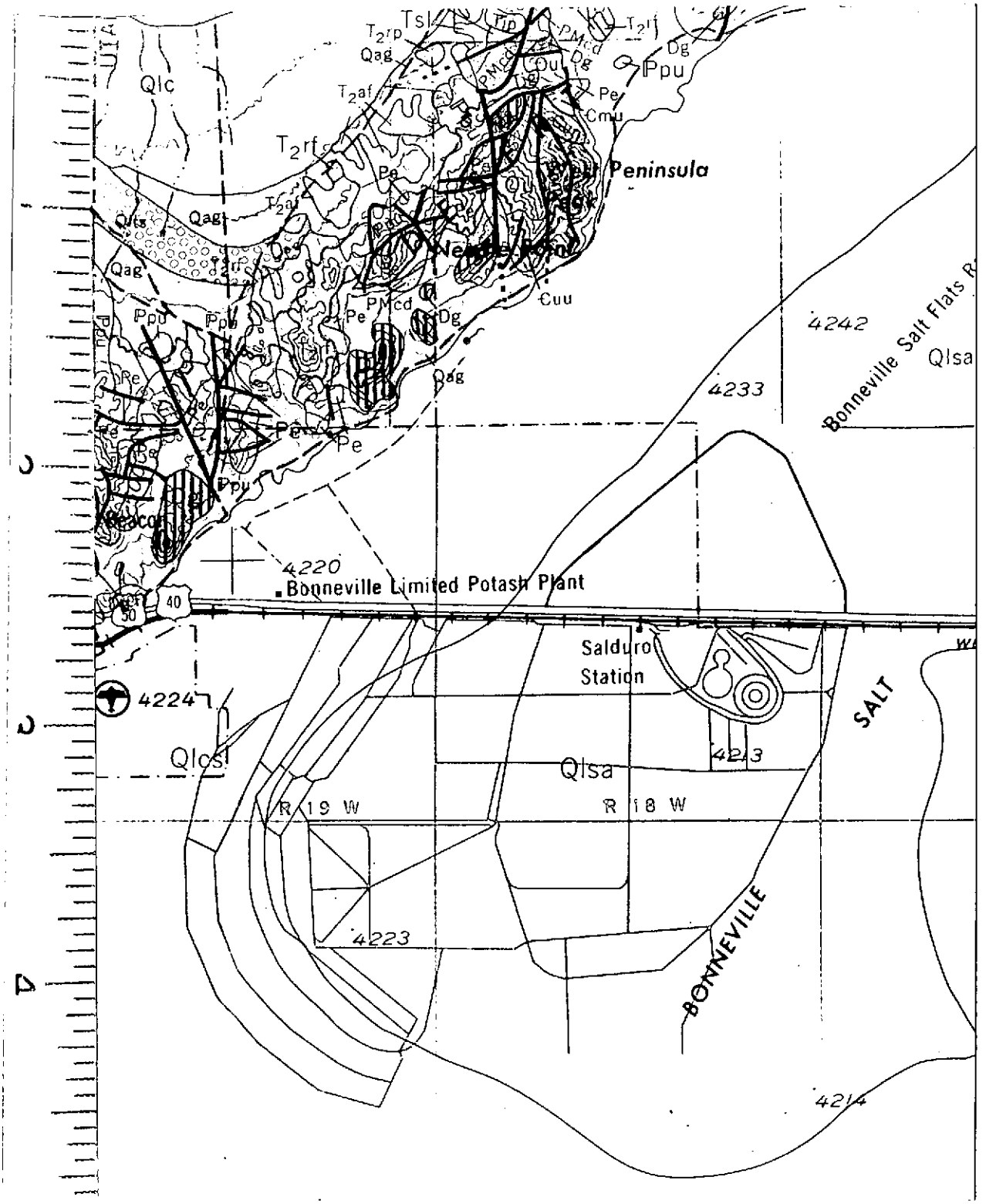
Index map of ERTS-1 images and EREP pass lines. Each pin on this photograph indicates a set of 4 ERTS images, the colors indicate cloud cover. The diagonal lines indicate the EREP tracks of SL-2 and SL-4, SL-3 tracks occurred between the diagonal lines.

Bonneville Salt Flats, Tooele County, Utah, and Elko County, Nevada

To the casual observer, the Salt Flats of western Utah appear to be uniformly white. All space craft imagery vividly indicates that this is not true as variations in composition and moisture cause marked differences in reflected portions of the visible and near infra red spectrum.

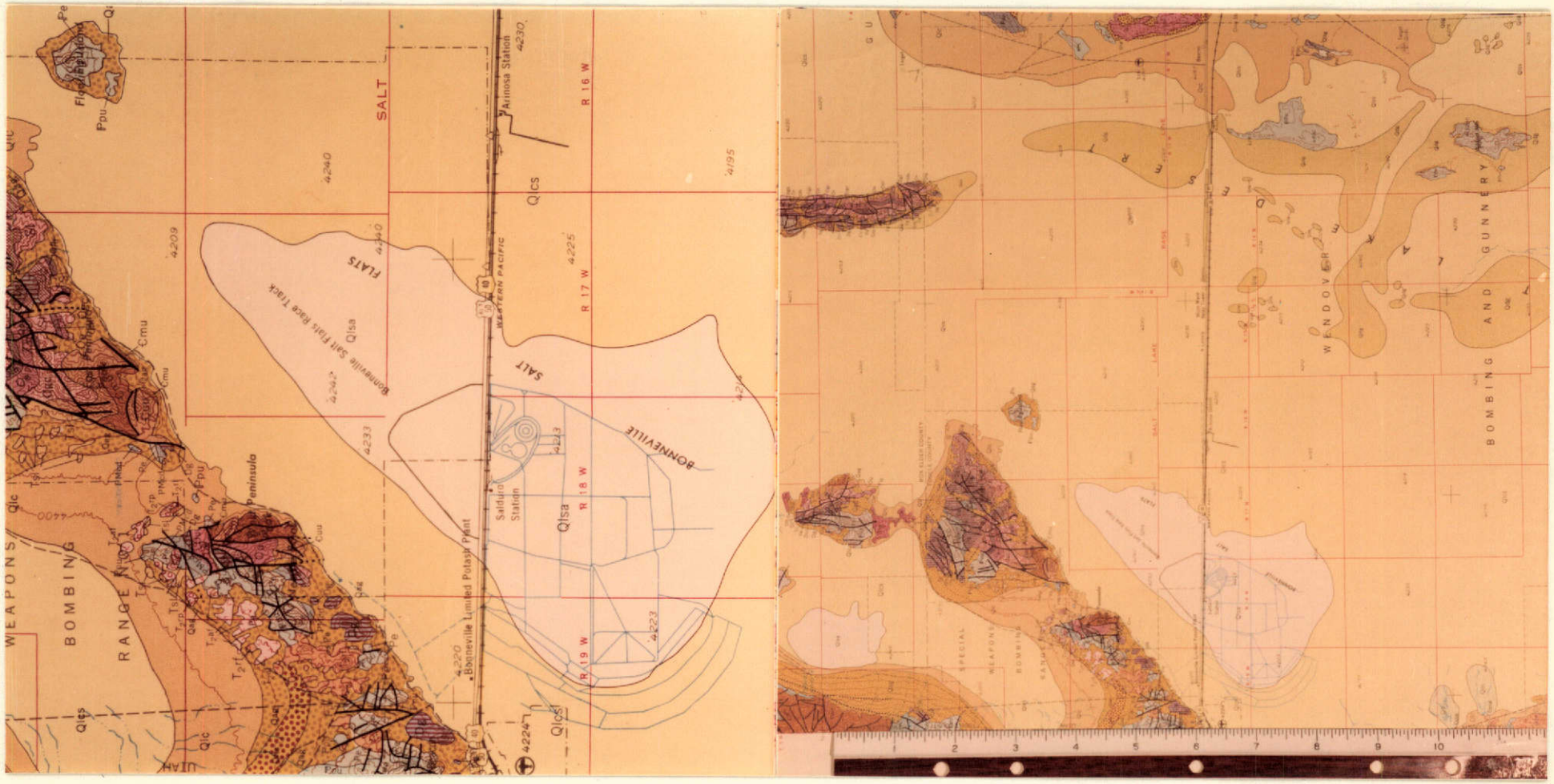
The following ERTS-1, EREP, and RB-57 images and enlargements illustrate the various application of each image to hydrologic and geologic features and include comparison of the products for clarity and usefulness.

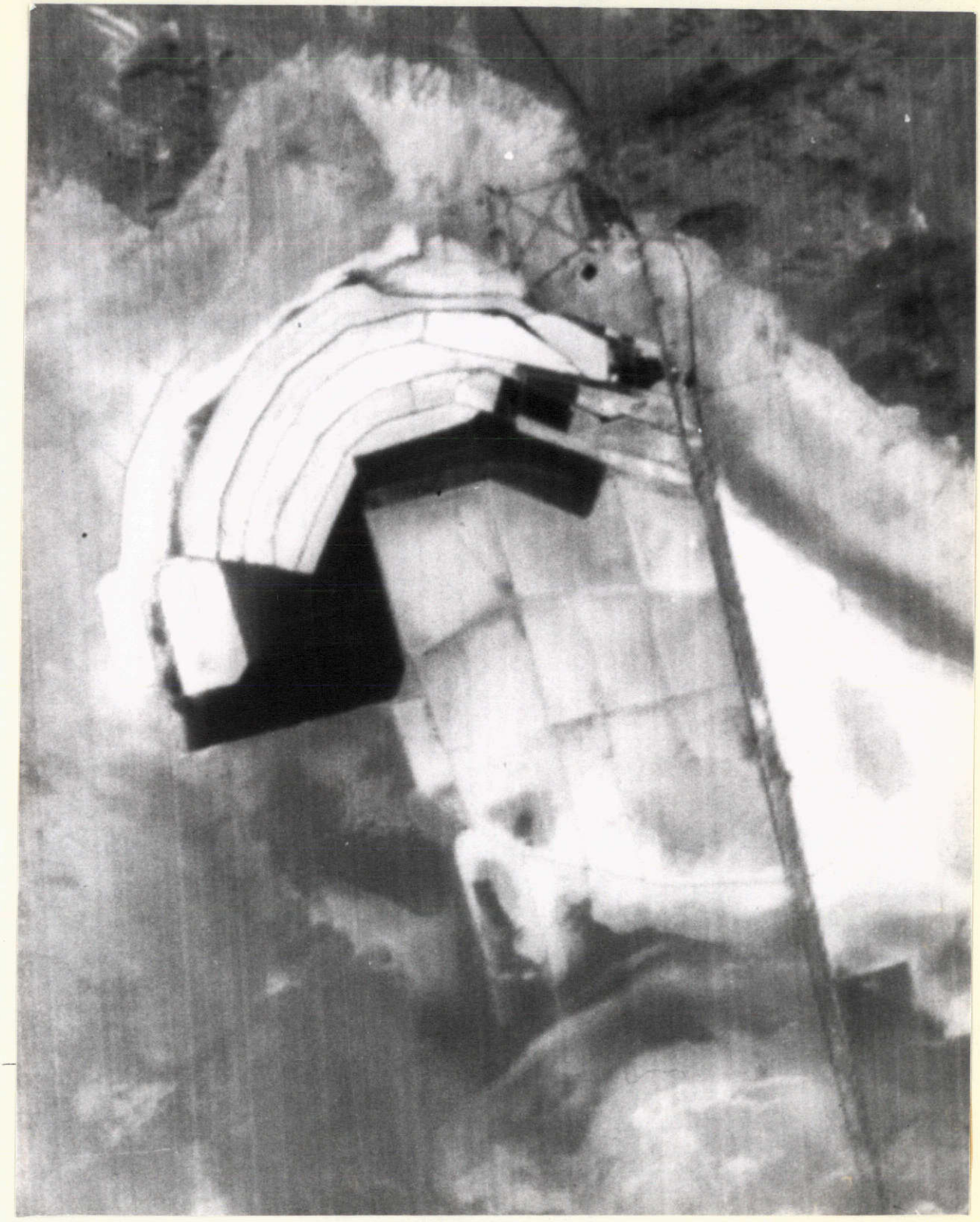
Specific details, scales, and comments on the images is included on the images.



Geologic map of solar evaporation ponds and geologic features.
Scale: 1/140,000

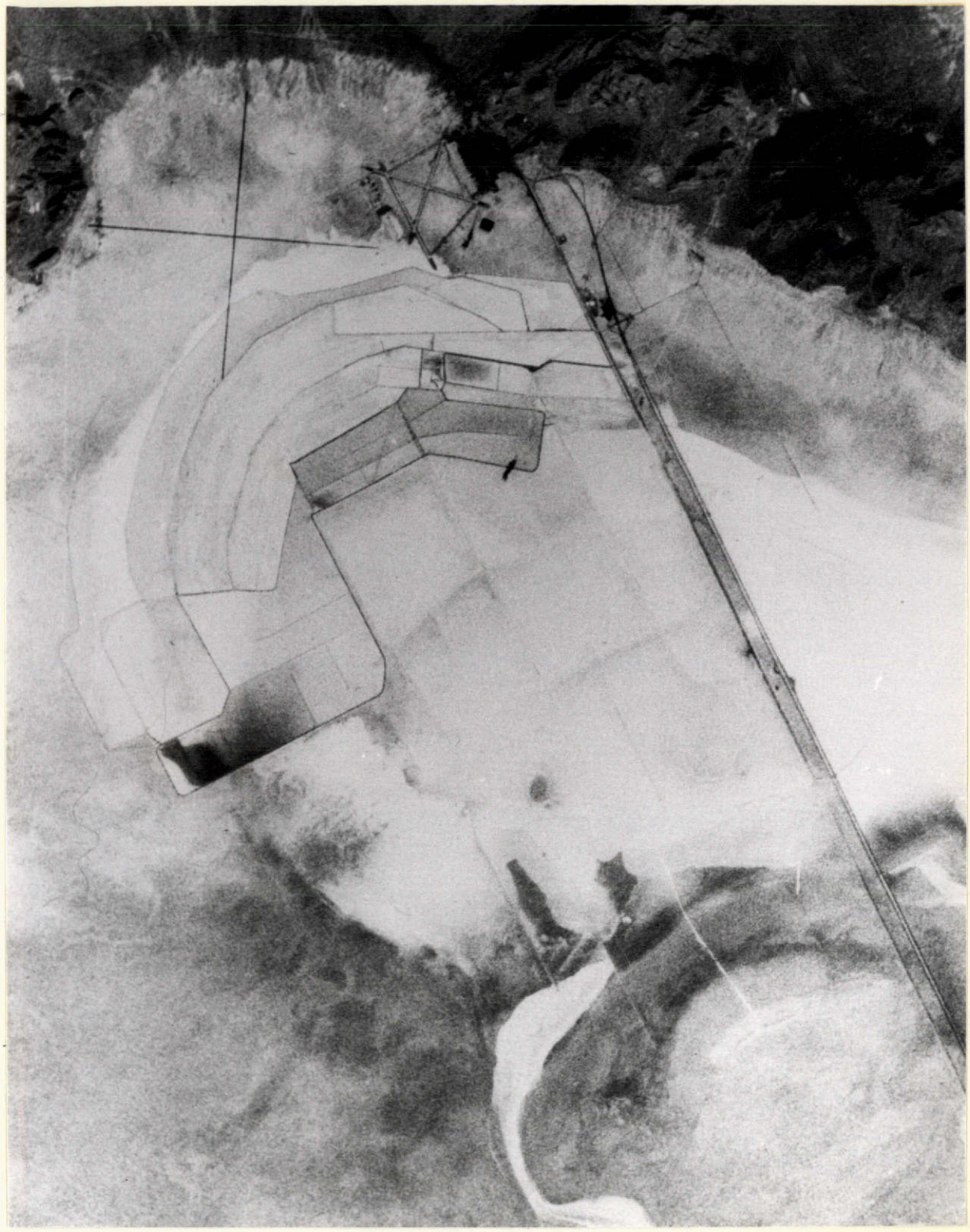
COLOR PRINTS OF PARTS OF STATE AND COUNTY GEOLOGIC MAPS COVERING DISTRICTS OF THIS REPORT.
ORIGINAL SCALE 1:250,000. NOTE RULER FOR PRINT SCALE.
BONNEVILLE SALT FLATS AREA





Bonneville Salt Flats, Tooele County, Utah,
Elko County, Nevada
Scale: 1/110,000

This enlarged ERTS-1 image of the Kaiser evaporite operation illustrates unusual detail. Even with the 5-fold increase in scale of the 9 x 9 positive transparencies of ERTS-1 (30 x original 70 mm tape), the airfield is quite evident, the interstate highway exhibits a ripple pattern where diagonal to the telescan lines, and the Lake Bonneville shorelines are evident in the northwestern portion of the image. There is blurring.

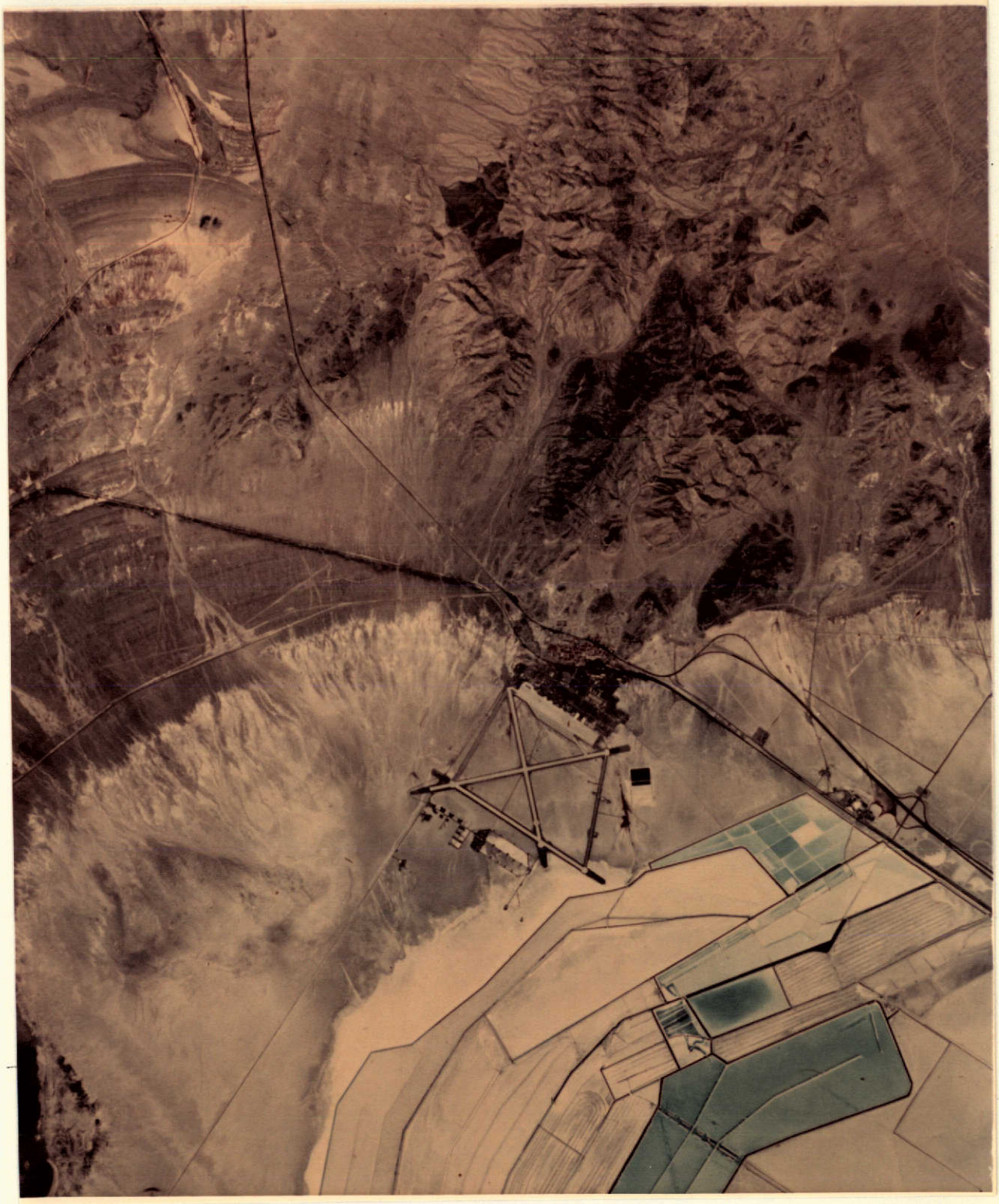


Part of S-190A Photograph - Bonneville, Utah Area
Scale: 1/110,000

For comparison of detail with ERTS photography of same scale.

Bonneville Salt Flats, Tooele County, Utah and
Elko County, Nevada
Scale: 1/45,000

This RB-57F color photograph illustrates the remarkable detail of these images. Other than the man-made evaporite ponds, highways, and airfield, this image exhibits geologic and geomorphic features in detail. Note the numerous Lake Bonneville shoreline terraces which can actually be counted better on this image than on the ground. The accompanying geologic map correlates well with geology shown on the northern portion of the photograph.

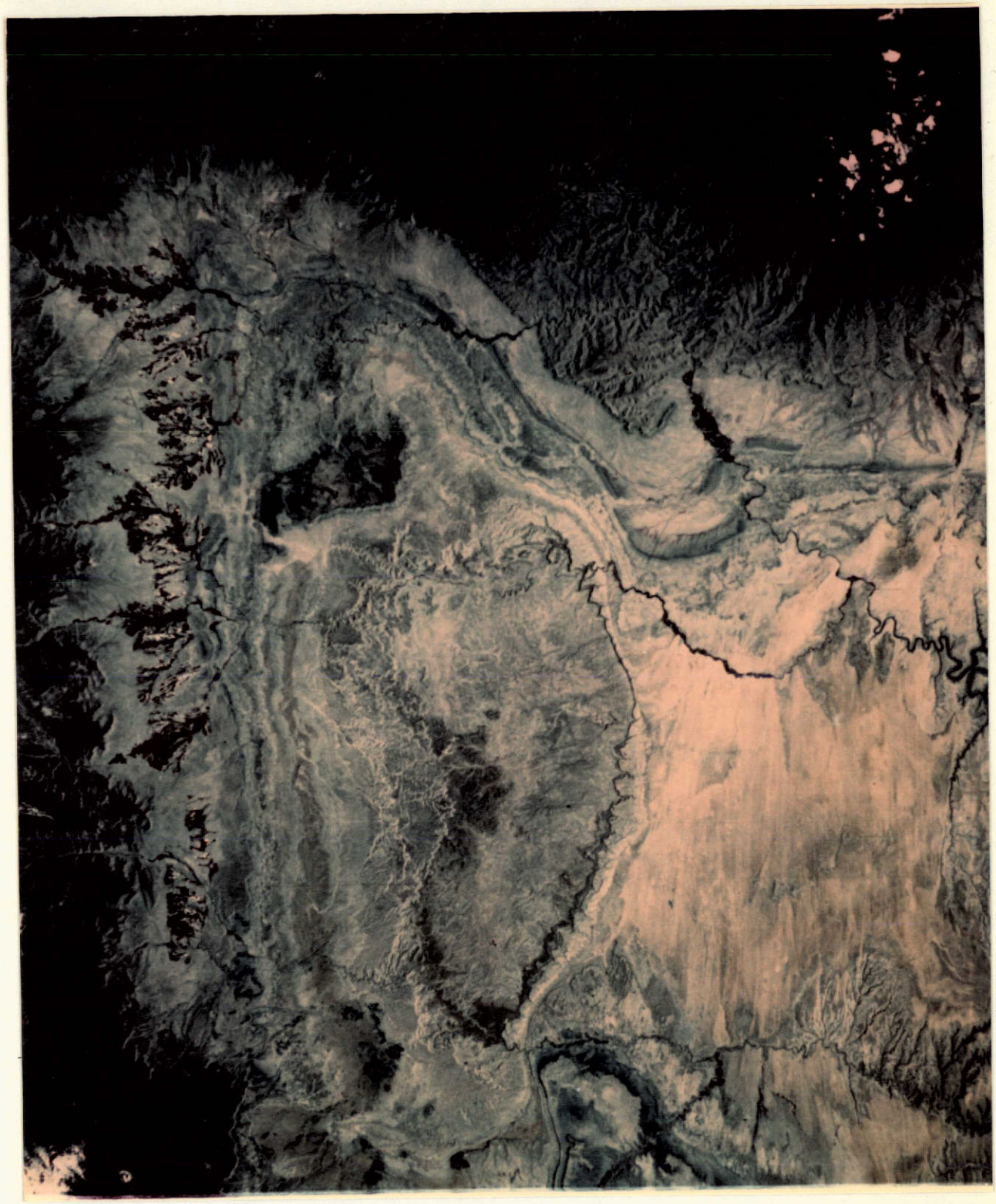


Bonneville Salt Flats, Tooele County, Utah
and Elko County, Nevada
Scale: 1/45,000

In contrast to the RB-57F color photograph, this RB-57F color IR photograph not only illustrates the moisture and water in the solar evaporite ponds but also exhibits the geologic and geomorphic features more clearly. Compare the northern rock formation on this image with the enclosed geologic map of this area. Geologic mapping could be done with greater ease with the color IR image versus the color photograph. Even this scale of 1" = 45,200 ft., detail is well exposed and the images can withstand considerable more enlargement.

San Rafael Swell to Moab, Utah
Emery and Grand County, Utah
Scale: 1/800,000

Color print from 70 mm S-190A positive transparency, SL-2. Triassic, Jurassic, and Cretaceous formations show striking color changes. Broad folding, intricate in detail.



San Rafael to Moab, Utah
Emery and Grand County, Utah
Scale: 1/800,000

IR color from 70 mm S-190A positive transparency, SL-2. Note improved detail in rock units in broad plain between San Rafael Swell and Green River west from Moab.

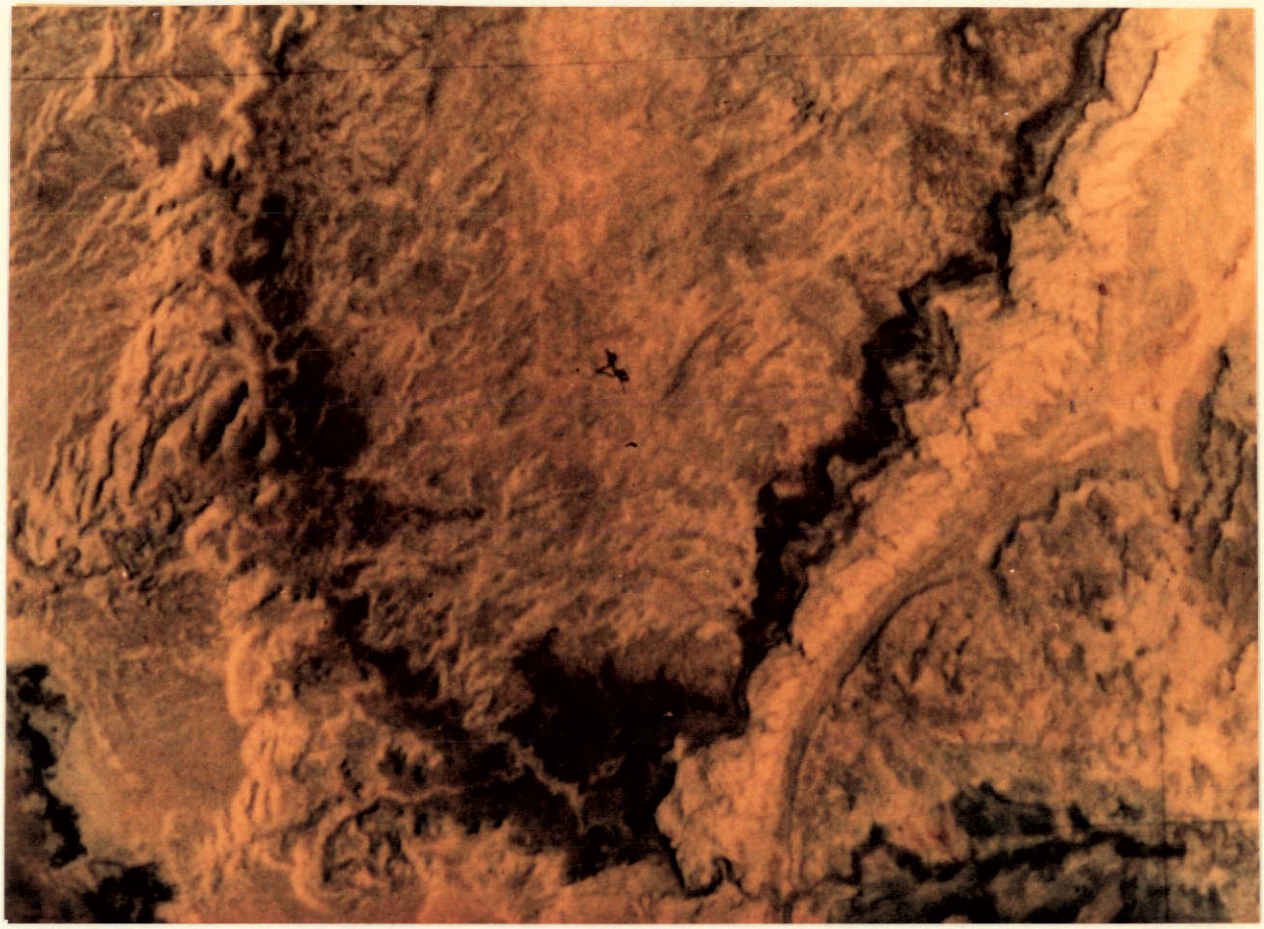
San Rafael Swell, Emery County, Utah
Scale: 1/500,000

B & W from S-190B photograph

San Rafael Swell, Emery County, Utah
Part of ERTS (Band 7)

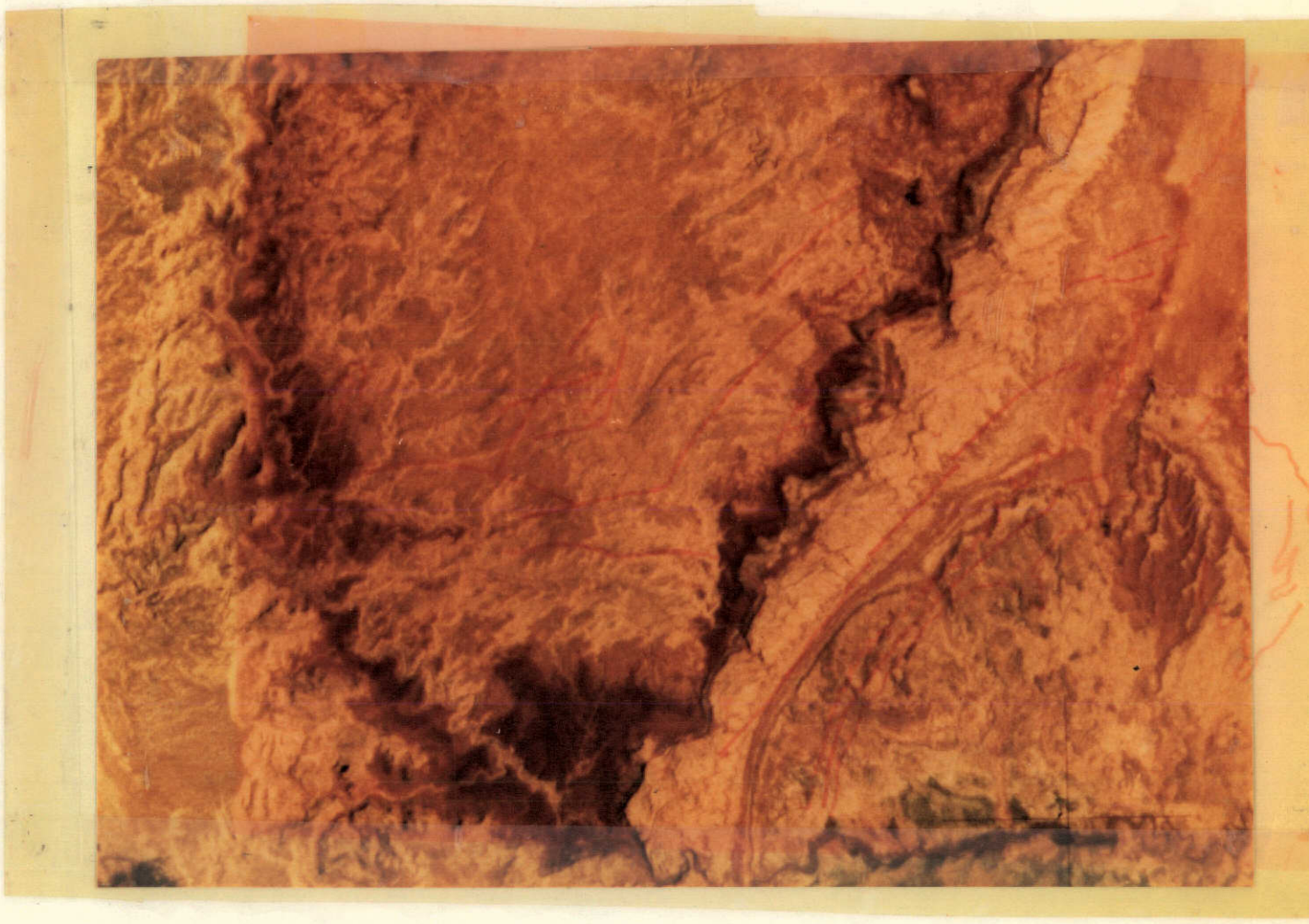
For comparison with S-190B of same scale. Large geologic units visible, but details quite obscure.

COLOR PRINTS OF PARTS OF STATE AND COUNTY GEOLOGIC MAPS COVERING DISTRICTS OF THIS REPORT.
ORIGINAL SCALE 1:250,000. NOTE RULER FOR PRINT SCALE.
SAN RAFAEL SWELL AREA



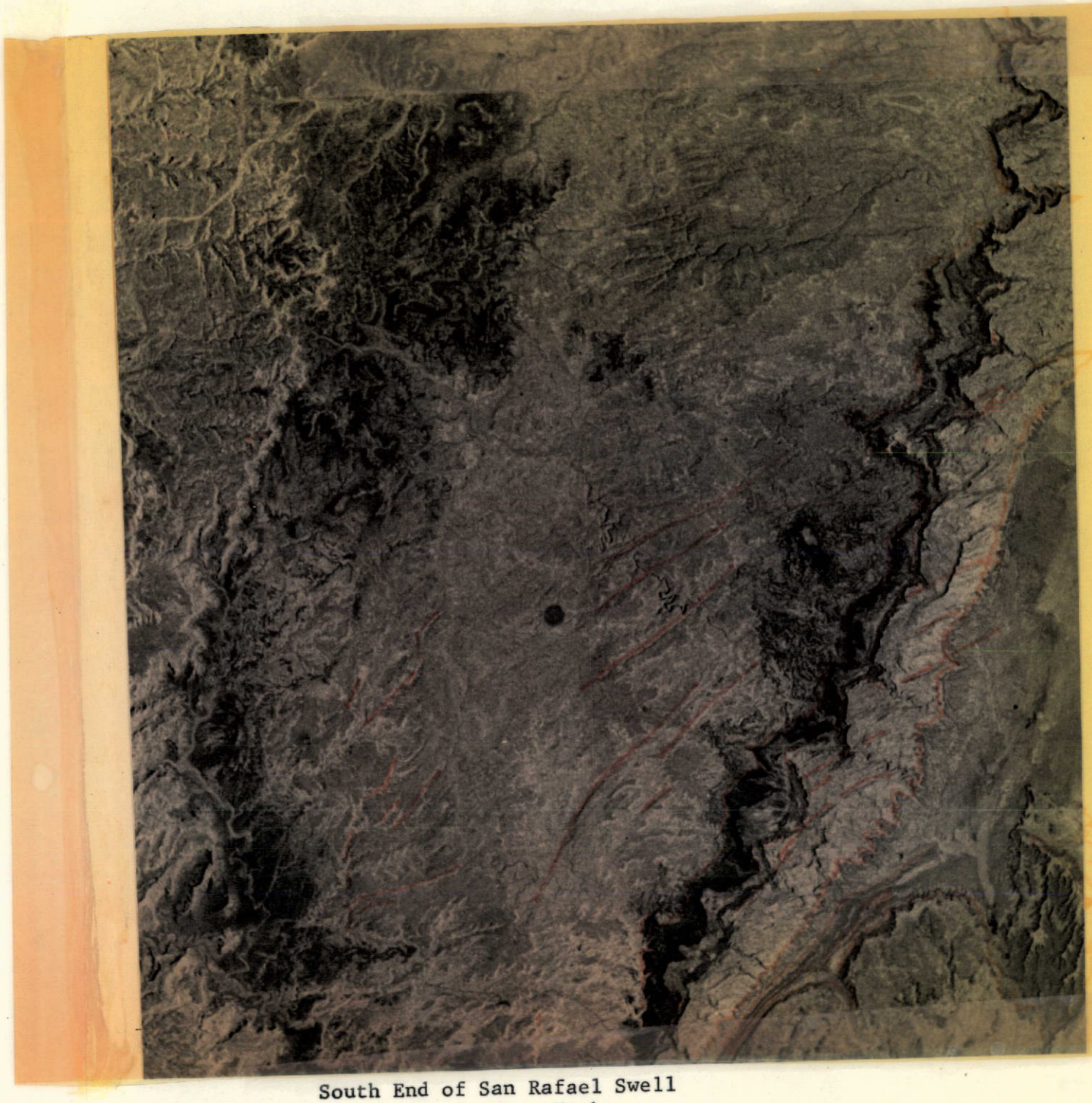
South End of San Rafael Swell
Emery County, Utah
Scale: 1/203,000

This is a S-190A normalized corrected IR color print enlarged from a 70 mm positive transparency provided from SL-2. Compare this to the tonal differences of the S-190A normal color print with overlay map.



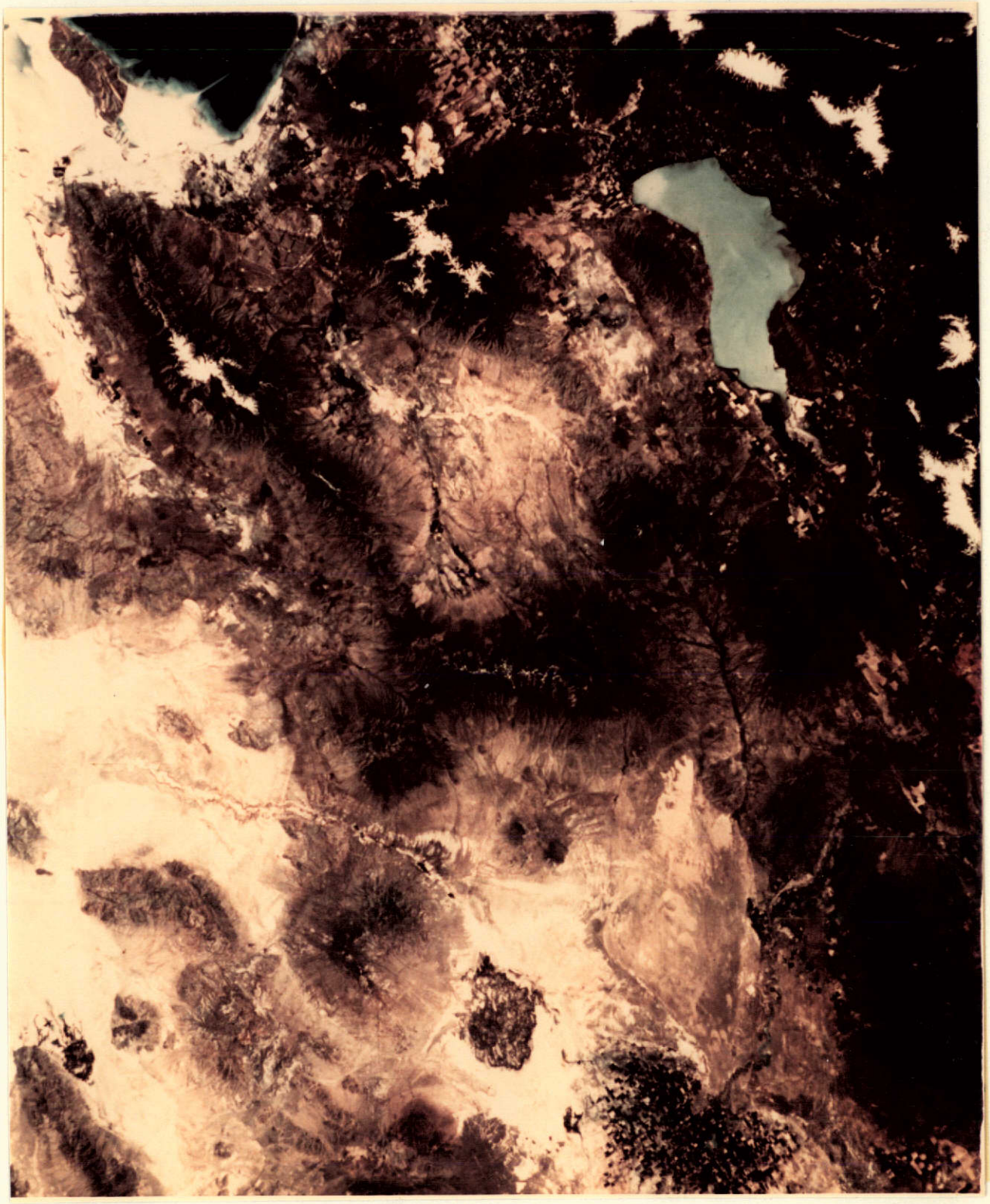
South End of San Rafael Swell
Emery County, Utah
Scale: 1/203,000

This is a S-190-A color print enlarged from a 70 mm positive transparency provided from SL-2. Note the loss in detail and slight fuzziness of the imagery. Contrast this image and the transparent overlay showing faults and geologic contacts with the improved imagery of the B & W S190-B images and the more detailed geologic features indicated on the transparent overlay.



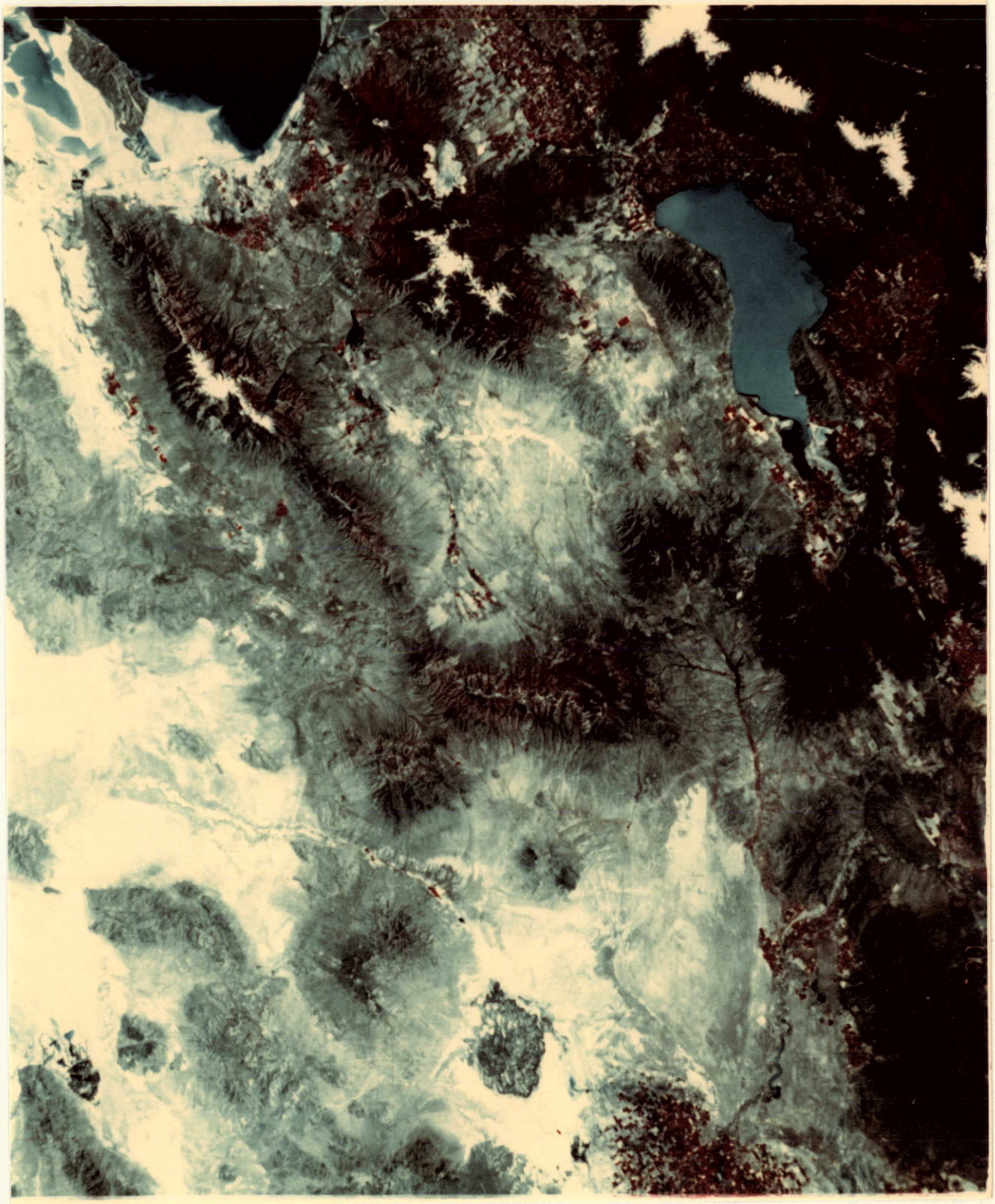
South End of San Rafael Swell
Emery County, Utah
Scale: 1/250,000

This is a S-190B, B & W print enlarged from a 5" positive color transparency provided by SL-2. Note the vastly increased detail of geologic and geomorphic features on this image in contrast to the enlarged IR and color prints. The difference in detail is the result of fine-grained film and a larger initial image size by a factor of 2 over S-190A. With at least twice as fine film grain the above image is improved in detail by a factor of at least four.



Bingham, Utah Lake, and Desert west of Wasatch Front
Scale: 1/728,000

Color photograph of S-190A photograph that shows lack of detail of Bingham Pit (located in upper center of image). Compare to enlargements on following pages and little loss in detail with enlargements. Also note silt pattern of bottom sediments of Utah Lake.



Bingham, Utah Lake, and Desert west of Wasatch Front
Scale: 1/728,000

Color IR S-190A photograph showing lack of detail of Bingham Pit and not as much detail as following enlargements.

Bingham Porphyry Copper Deposit, Salt Lake City, Utah
Scale: 1/185,000

This ERTS-I image is an enlargement of the Oquirrh range and the western portion of Salt Lake City, Utah. The Bingham pit is located in the center of the image. Note that this image does not exhibit the clarity of the following EREP S-190B photograph with the noteable exception that the relief of the Oquirrh range and lineation trends are as well defined on the ERTS-1 image as on the EREP photograph.

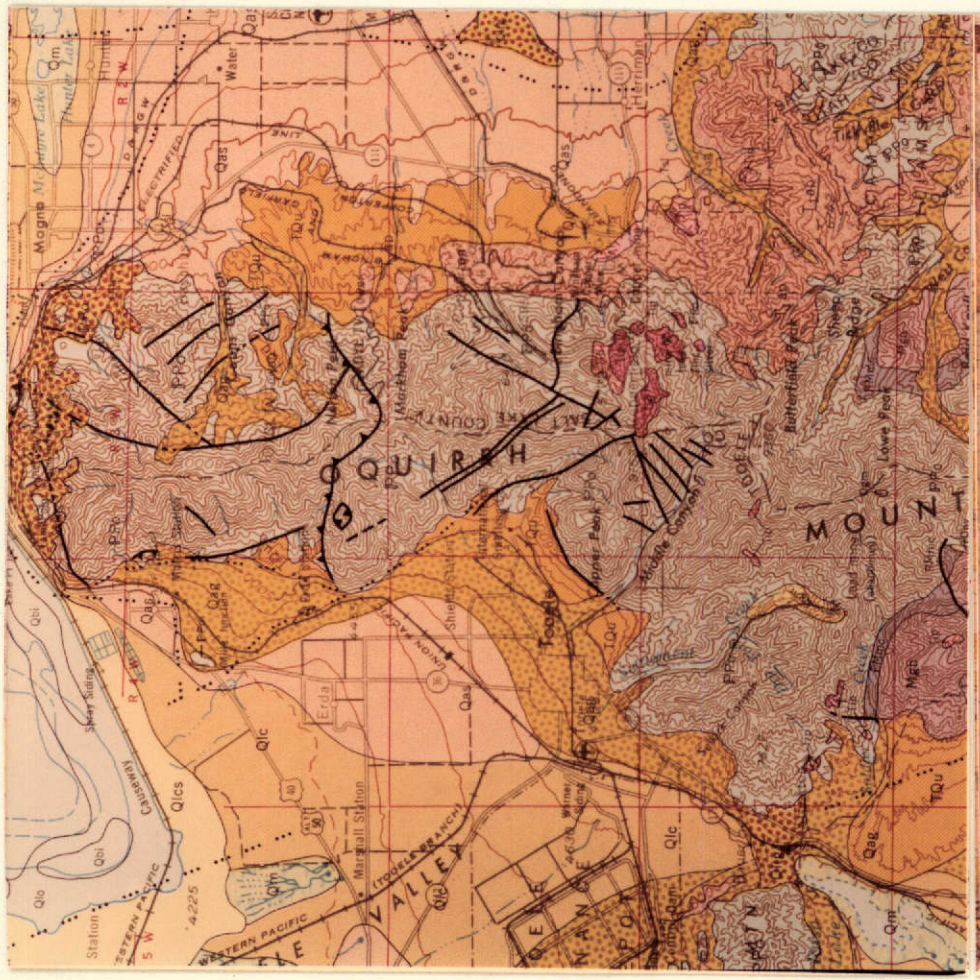
Bingham Porphyry Copper Deposit, Salt Lake City, Utah
Scale: 1/185,000

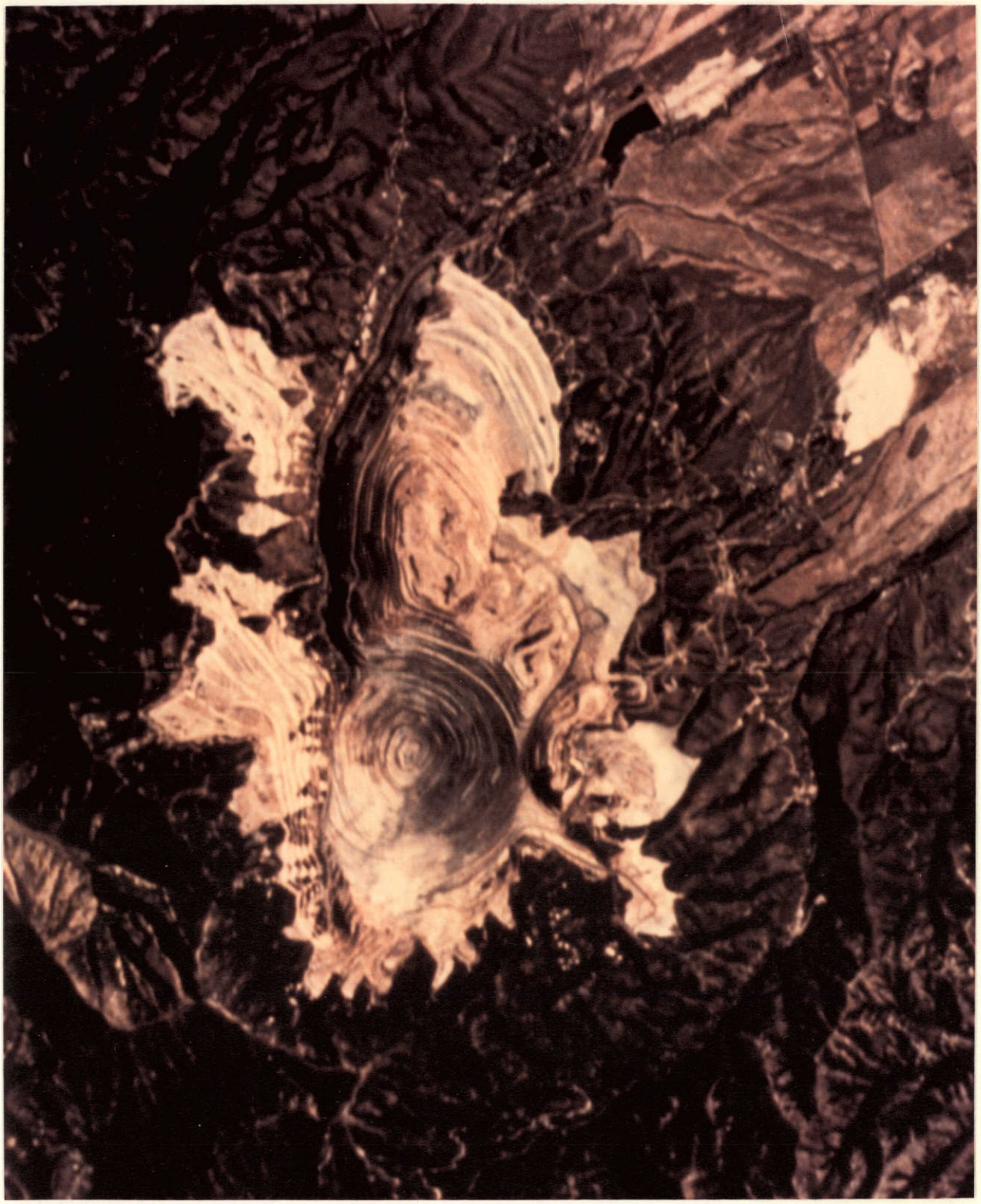
This S190-B image is an enlargement of the Oquirrh range and the western portion of Salt Lake City, Utah. The Bingham pit is located in the center of the image. Note that the pit levels are quite evident in this photograph but tonal difference in the rock requires color or IR color enlargements, as illustration in the following two photographs.

Geologic Map of Bingham Porphyry Copper Area
Scale: 1/145,000

Area of intrusive rock is colored in red. Note that this correlates with dark area on enlargements of Bingham Pit.

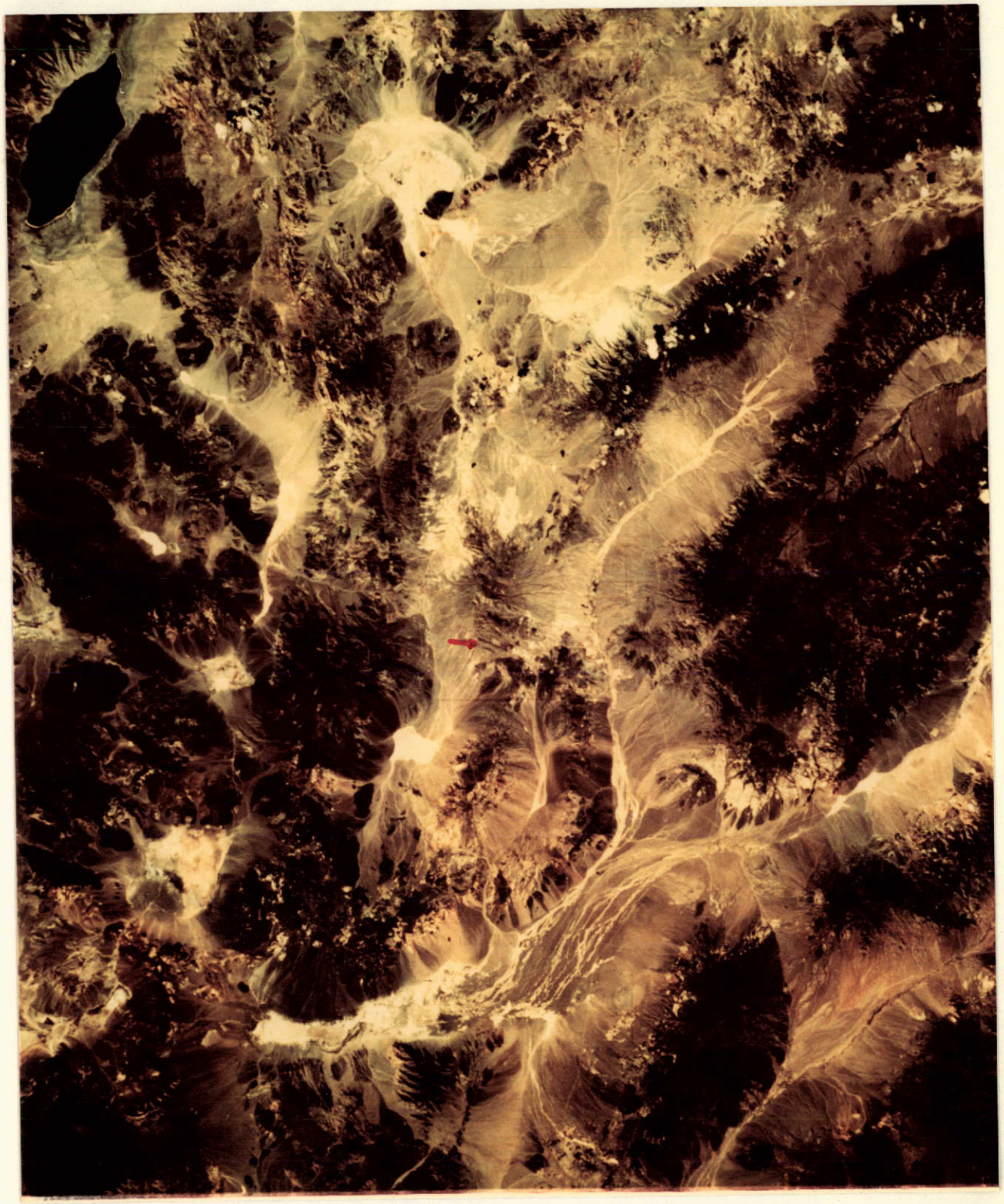
COLOR PRINTS OF PARTS OF STATE AND COUNTY GEOLOGIC MAPS COVERING DISTRICTS OF THIS REPORT.
ORIGINAL SCALE 1:250,000. NOTE RULER FOR PRINT SCALE.
BINGHAM AREA





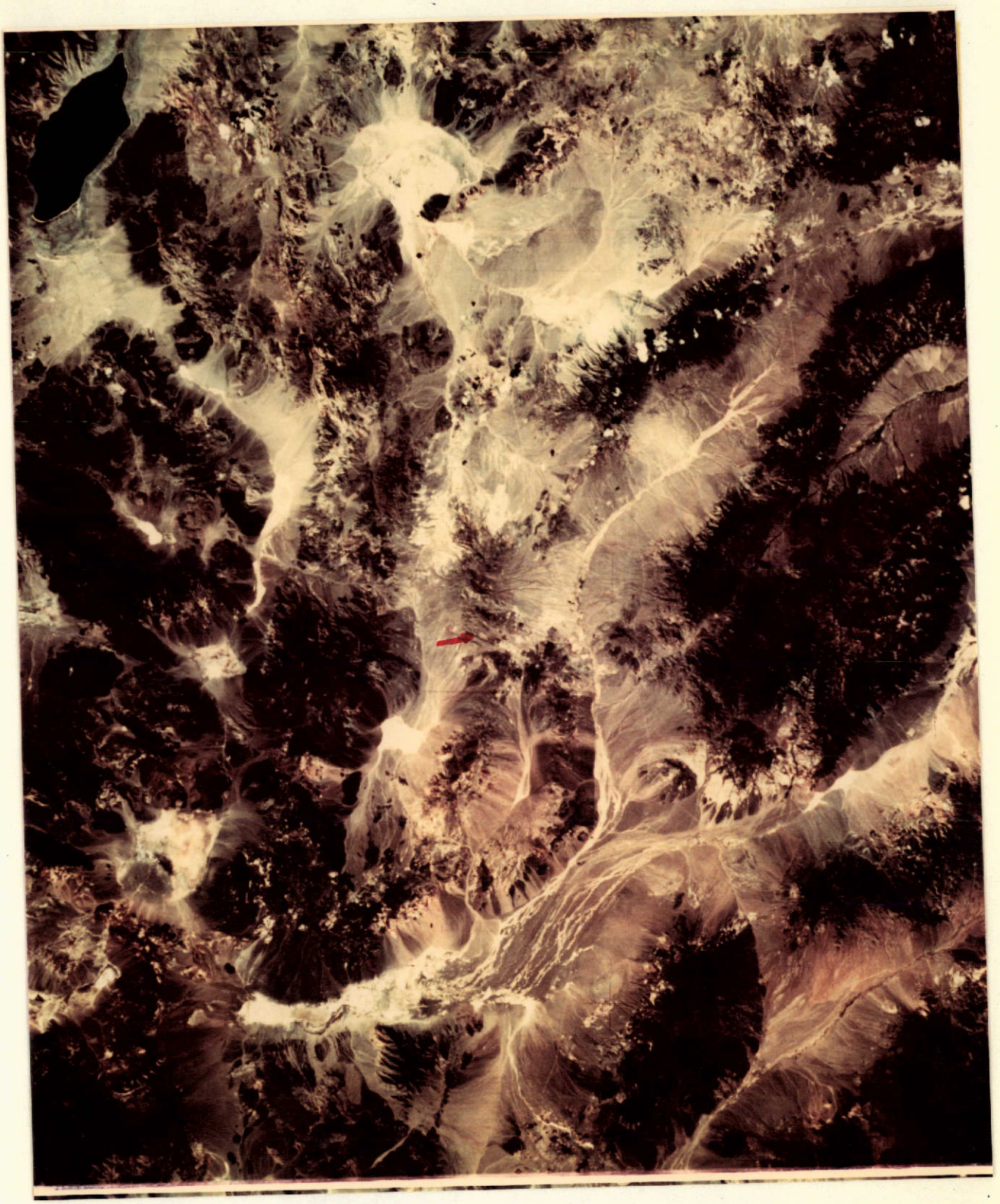
Bingham Porphyry Copper Deposit, Salt Lake County, Utah
Scale: 1/19,200

This vertical enlargement of a portion of an S-190B color photograph exhibits remarkable detail of the pit levels, differing waste dumps, what is even more significant, the geological formations, hydrothermal replacement, and lithologic variations are well exhibited within the pit.



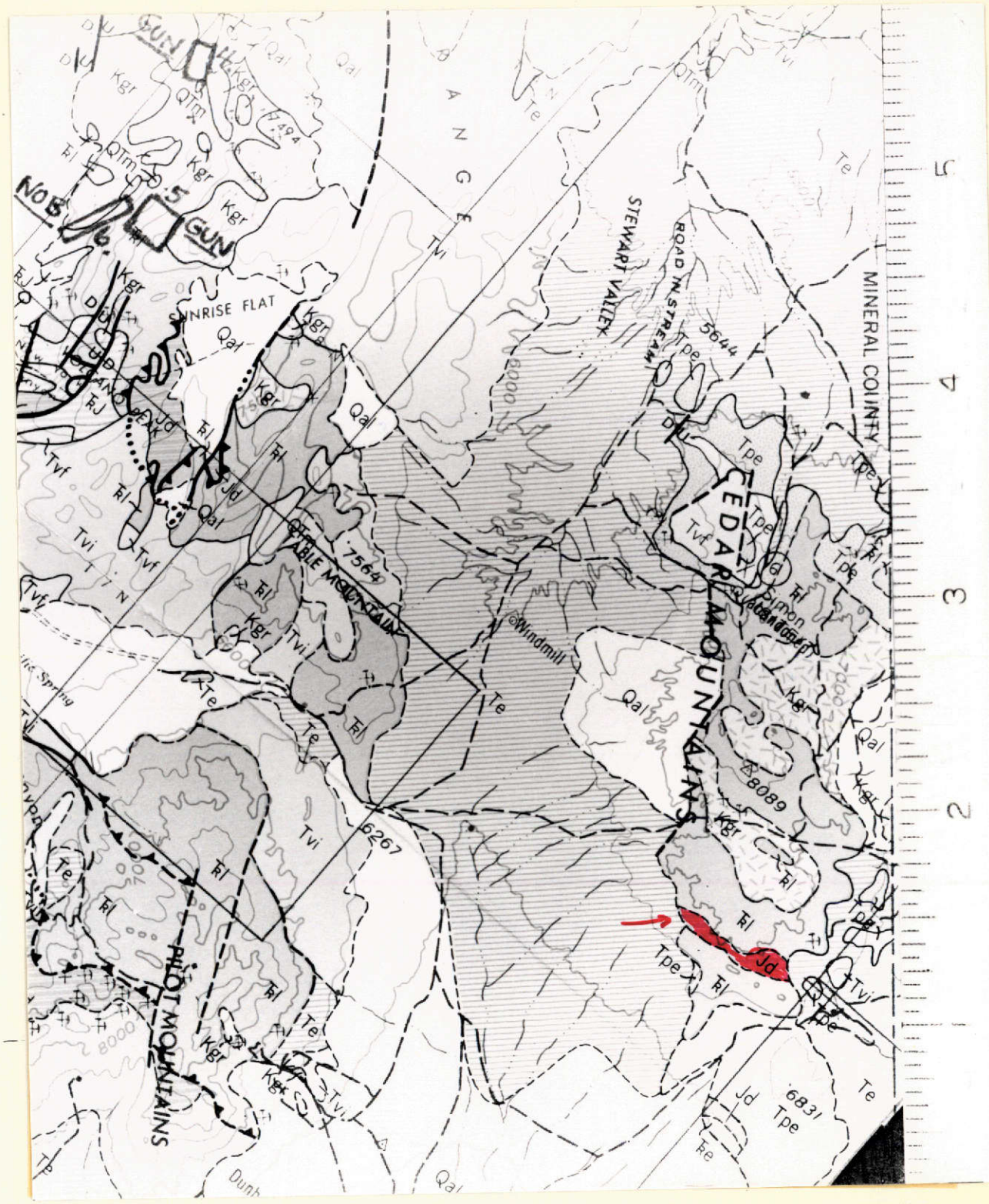
Cedar Mountains, Mineral County, Nevada
Scale: 1/728,000

Color photograph of S-190A (warm print) showing lack of detail of homoclinal structure as indicated by red arrow.



Cedar Mountain, Mineral County, Nevada
Scale: 1/728,000

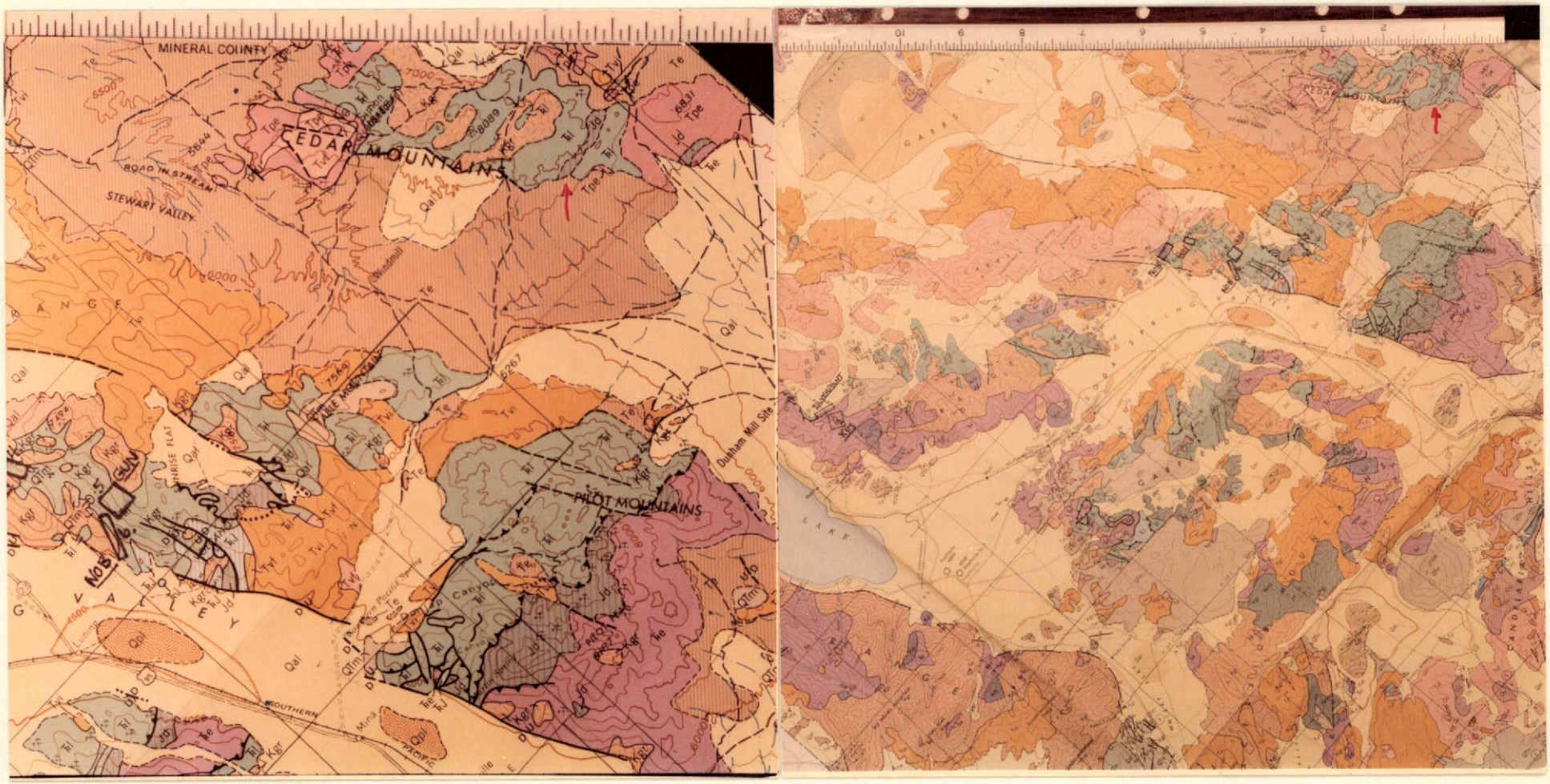
Color photograph of S-190A (color print). Note that homoclinal structure is mere line on this image.



Cedar Mountains, Mineral County, Nevada
Scale: 1/167,000

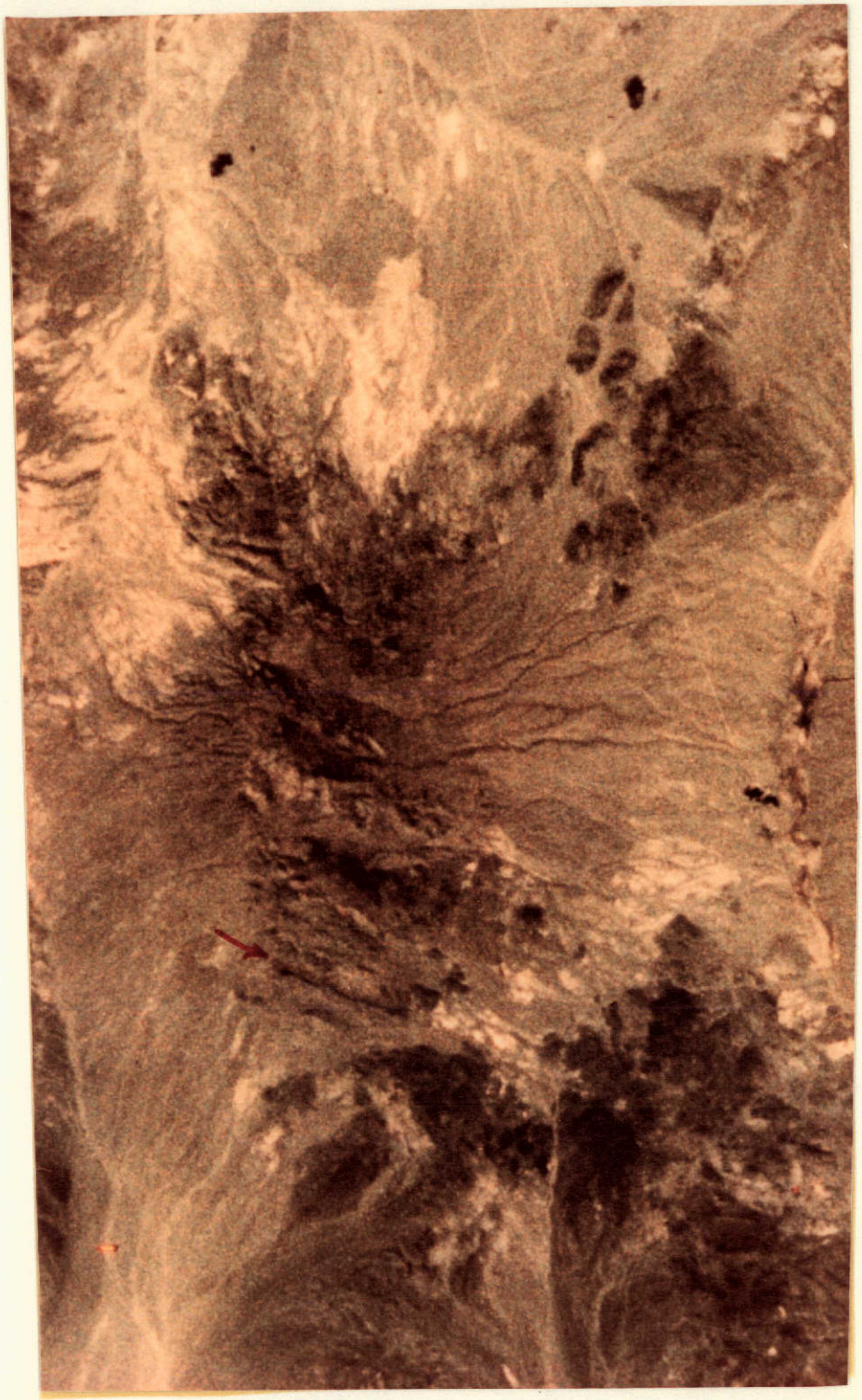
Red rock unit on photographs Jd - Jurassic Ss.

COLOR PRINTS OF PARTS OF STATE AND COUNTY GEOLOGIC MAPS COVERING DISTRICTS OF THIS REPORT.
ORIGINAL SCALE 1:250,000. NOTE RULER FOR PRINT SCALE.
CEDAR MOUNTAINS AREA



Cedar Mountains, Mineral County, Nevada
Scale: 1/175,000

S-190A color photograph of homoclinal structure is indicated by arrow. Note scale in comparison to following enlargements.

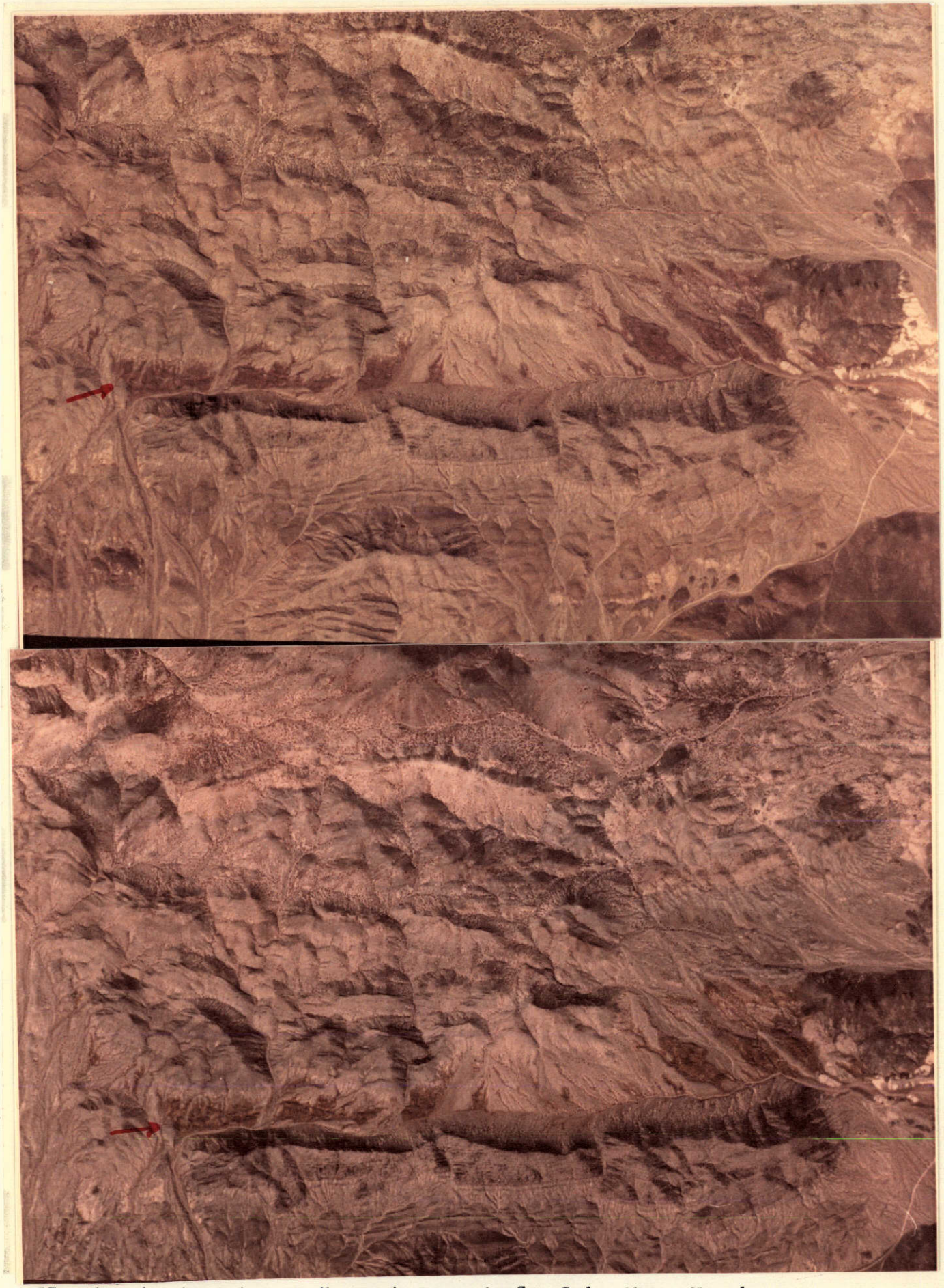


Cedar Mountains, Mineral County, Nevada
Scale: 1/175,000

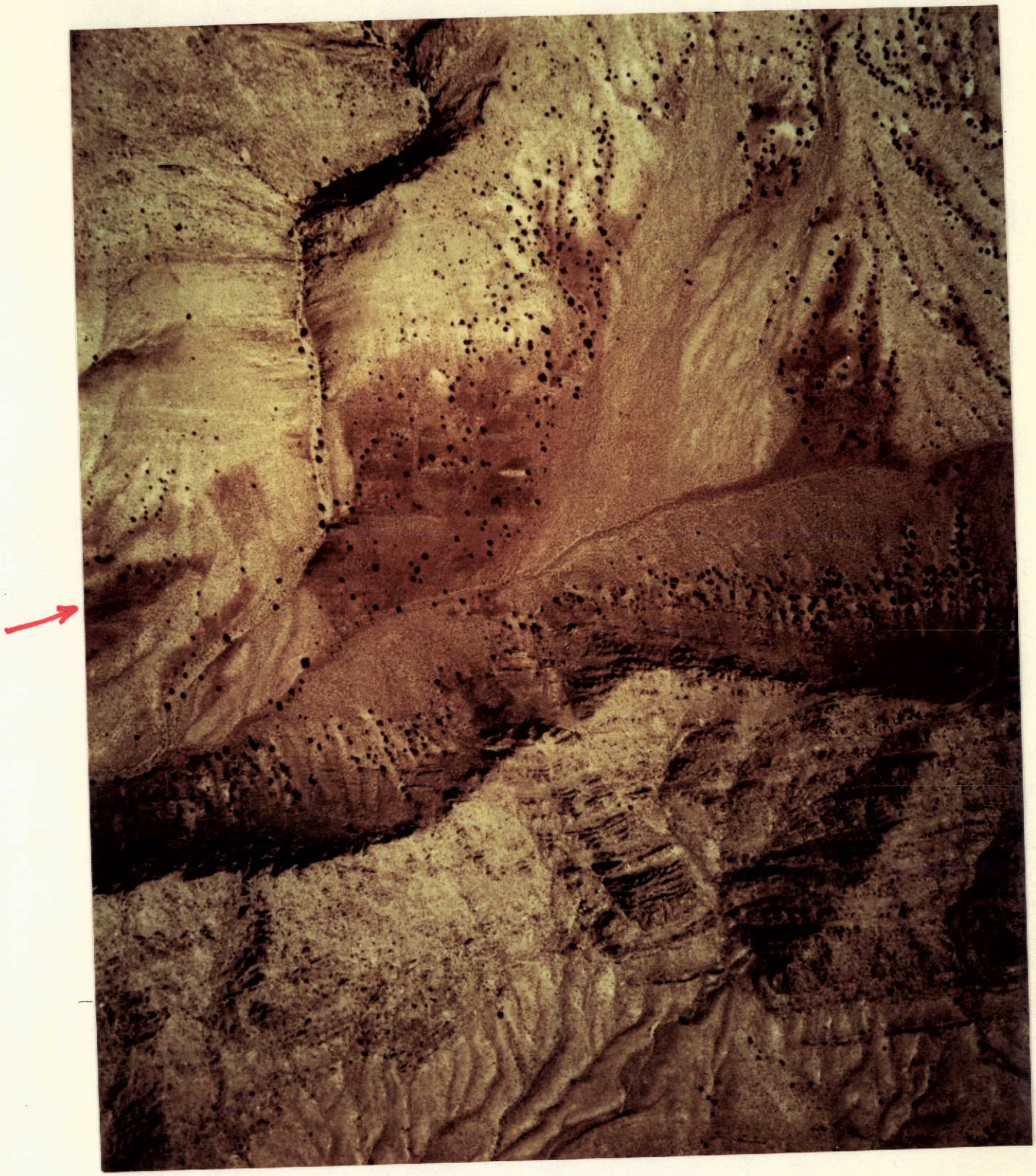
S-190A IR color photograph of monoclinal structure. Compare to enlargement that follow.

1/15 of a RB57 Photograph Covers South Half of Cedar Mts.
Scale: 1/20,000

Triassic, Jurassic, and Tertiary rocks. Intricate details of faulting and hydrothermal alteration well displayed on this scale.



RB57 Color (top), Color IR (bottom) Jurassic Ss, Cedar Mts., Nevada

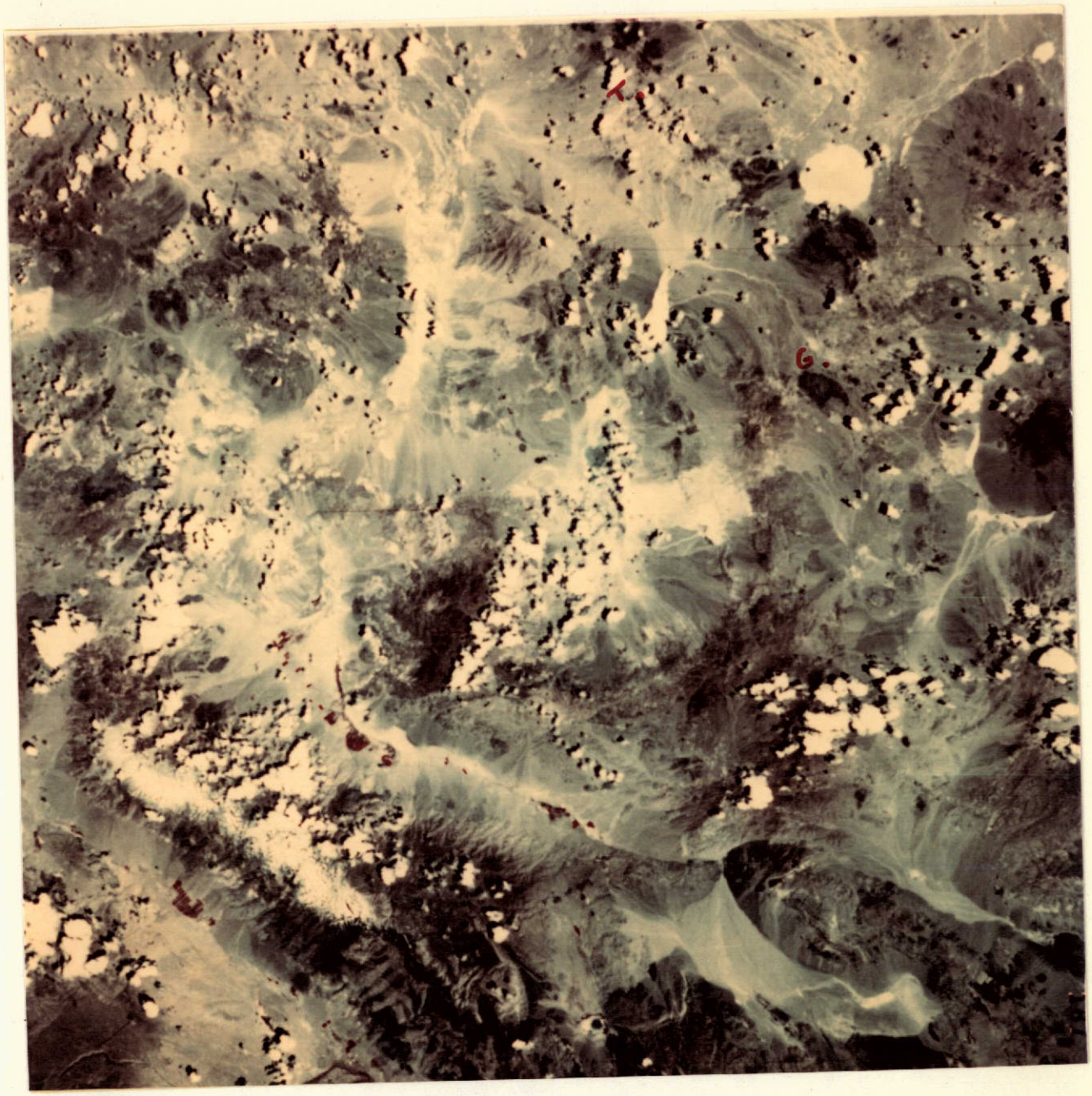


South Central Cedar Mts., Mineral County, Nevada
Scale: 1/6,000

One of a set of 200 covering Cedar Mts. Red Jurassic Dunlap Formation. Fairly conformable with underlying Triassic ? Formation, and overlain by discordant Triassic Luning Formation (Thrust Block.) Internal details of rock units show well on this scale.

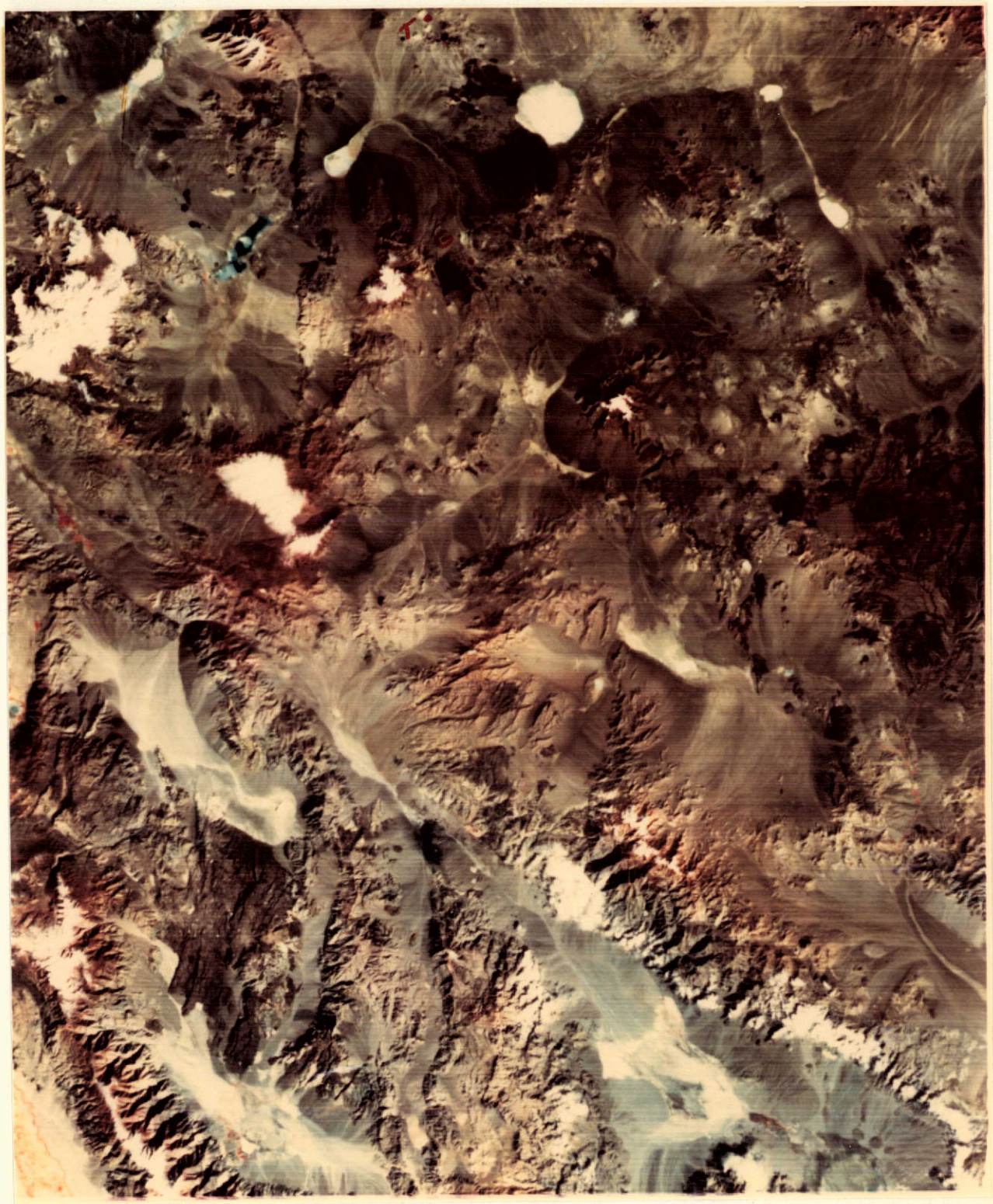
Tonopah- Goldfield and Country S.W. to Inyo Range.
Scale: 1/750,000

S-190A normal color. Comparison with ERTS color photo of the same area is instructive. Anomalies are identified by comparison between photo color changes for each rock unit. S-190A color vs S-190A IR color and ERTS color.

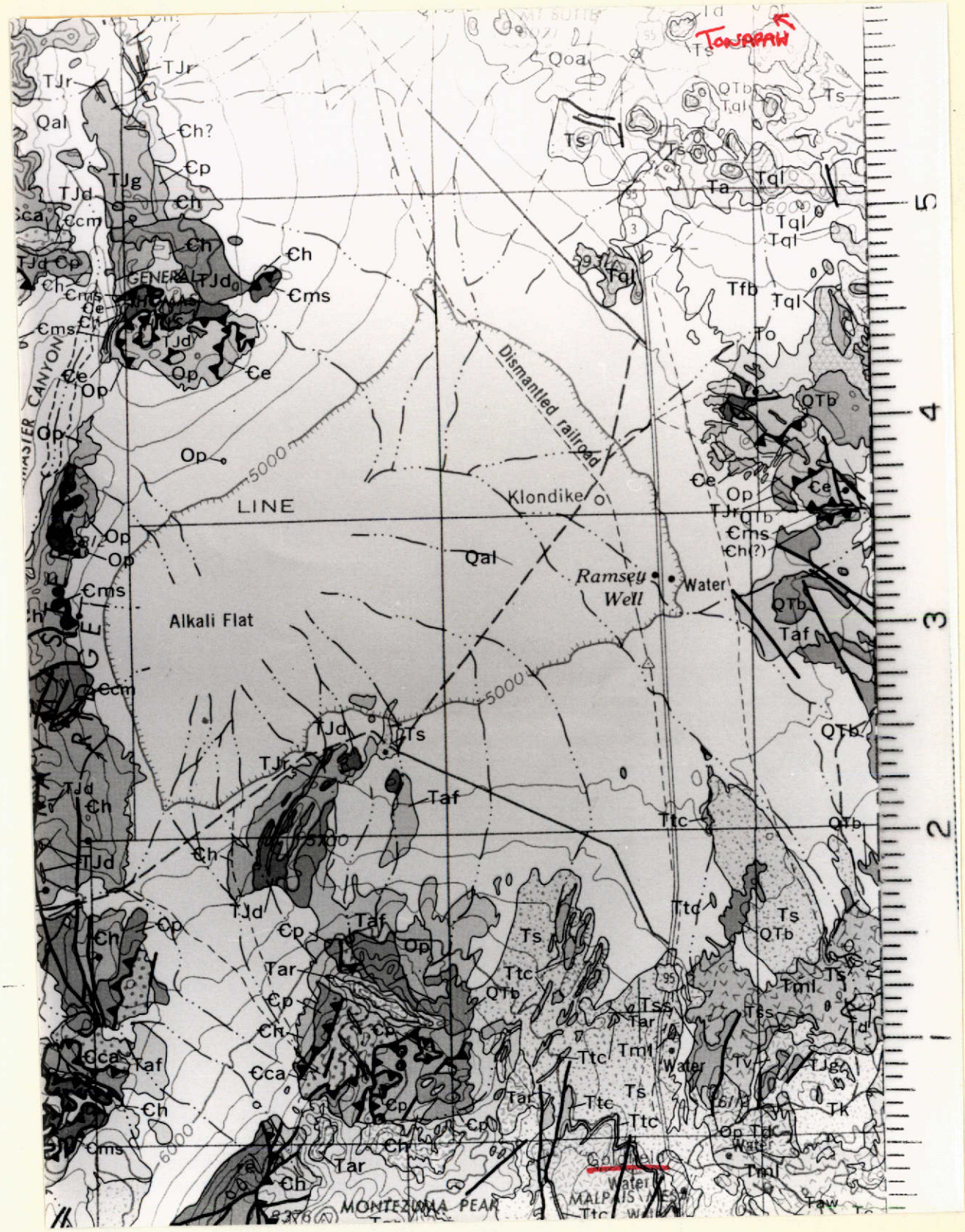


Tonopah-Goldfield plus NW Area
Scale: 1/750,000

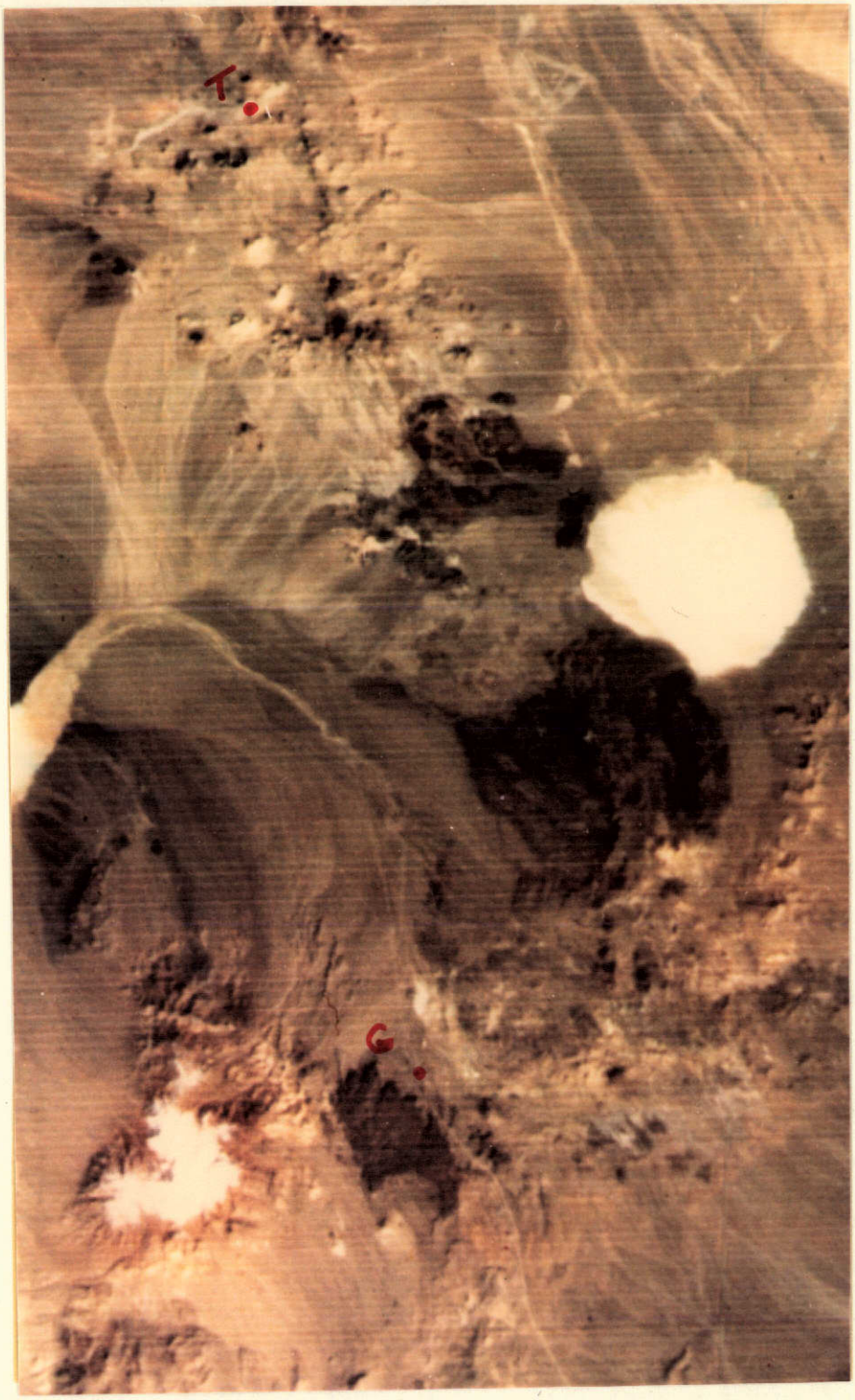
S-190A IR color. Only scattered anomalies on the IR color film are significant addition to those shown on normal color. Variagated colors in Tertiary volcanics indicative of broad hydrothermal alteration zones surrounding very small ore zones less than one square mile.



ERTS Goldfield - Tonopah Area, Esmeralda, Nevada
Scale: 1/750,000



Goldfield - Tonopah Area, Esmeralda, Nevada
Scale: 1/167,000



Goldfield-Tonopah Area
Scale: 1/250,000

Enlargement of the NE portion of ERTS color transparency. Excellent color differentiation of Tertiary volcanics with highly altered area north of the town of Goldfield (indicated with a G). Note the variagated colors which are the results of oxidation (primary and secondary) of pyrite in the Tr. rock.

COLOR PRINTS OF PARTS OF STATE AND COUNTY GEOLOGIC MAPS COVERING DISTRICTS OF THIS REPORT.
ORIGINAL SCALE 1:250,000. NOTE RULER FOR PRINT SCALE.
GOLDFIELD--TONOPAH AREA

Goldfield-Tonopah Area, Mineral County, Nevada
Scale: 1/250,000

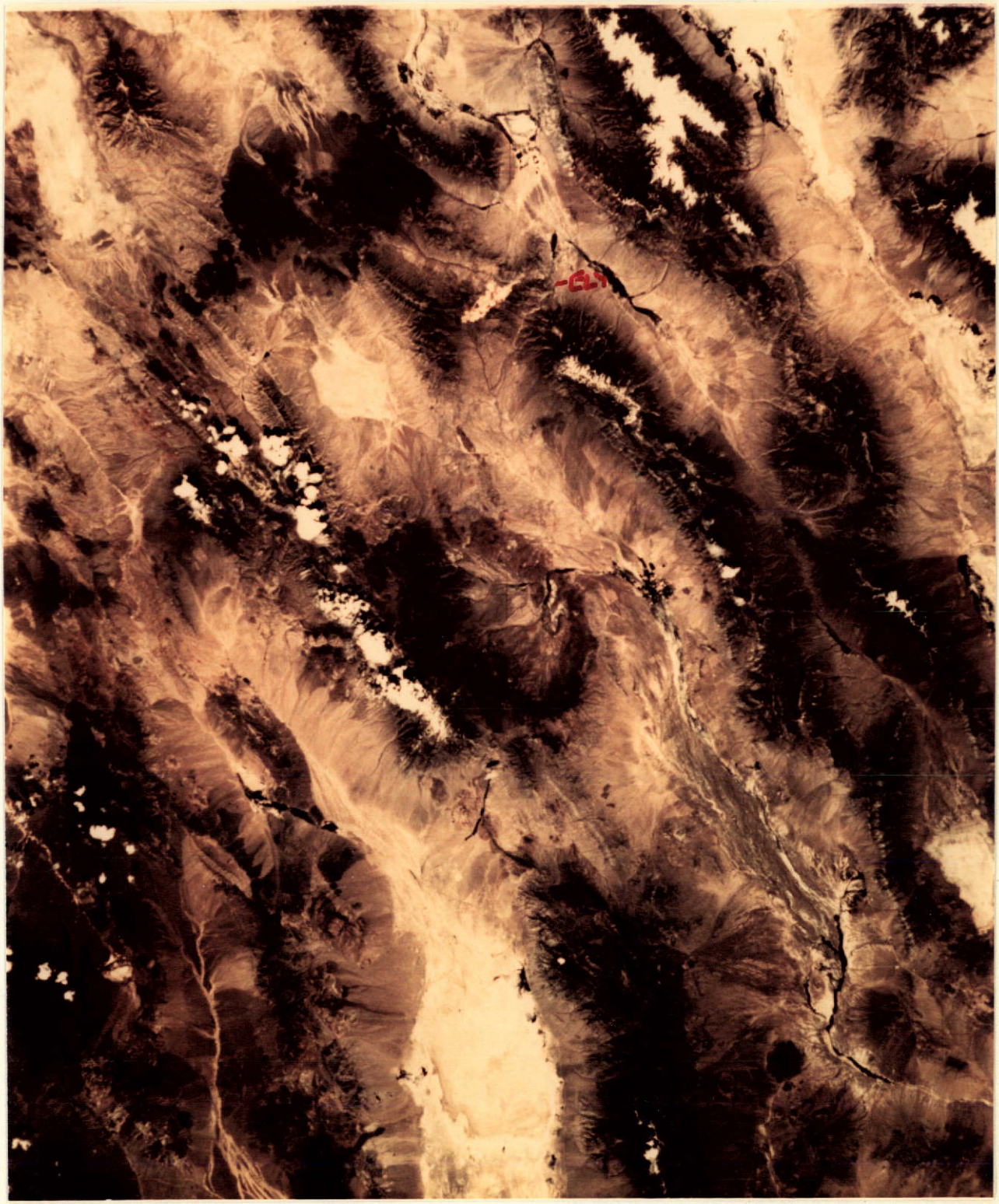
S-190A enlargement from 70 mm. Tertiary volcanic complex in Goldfield area well differentiated. Goldfield marked G., Tonopah T.

Robinson Mining District, White Pine County, Ely, Nevada

In the Robinson mining district, White Pine County, Nevada which includes the Ruth porphyry copper mines, three large positive aeromagnetic anomalies exist over the Ward Mountain area, the Ruth porphyry copper operations and over a Tertiary volcanic area northwest of Ruth. Prior studies of this area have suggested that the volcanics may be the cause of the anomalies. Skylab S-190A and ERTS-1 imagery, however, indicate outcrops in the volcanic area of the Paleozoic sediments and overlying younger Tertiary sediments. Field studies or ground truth verify the existence of these Paleozoic inliers suggesting that some of the magnetic anomalies may be the result of buried intrusive bodies for which potential mineralization has been covered by the post-ore "blanket" of volcanics.

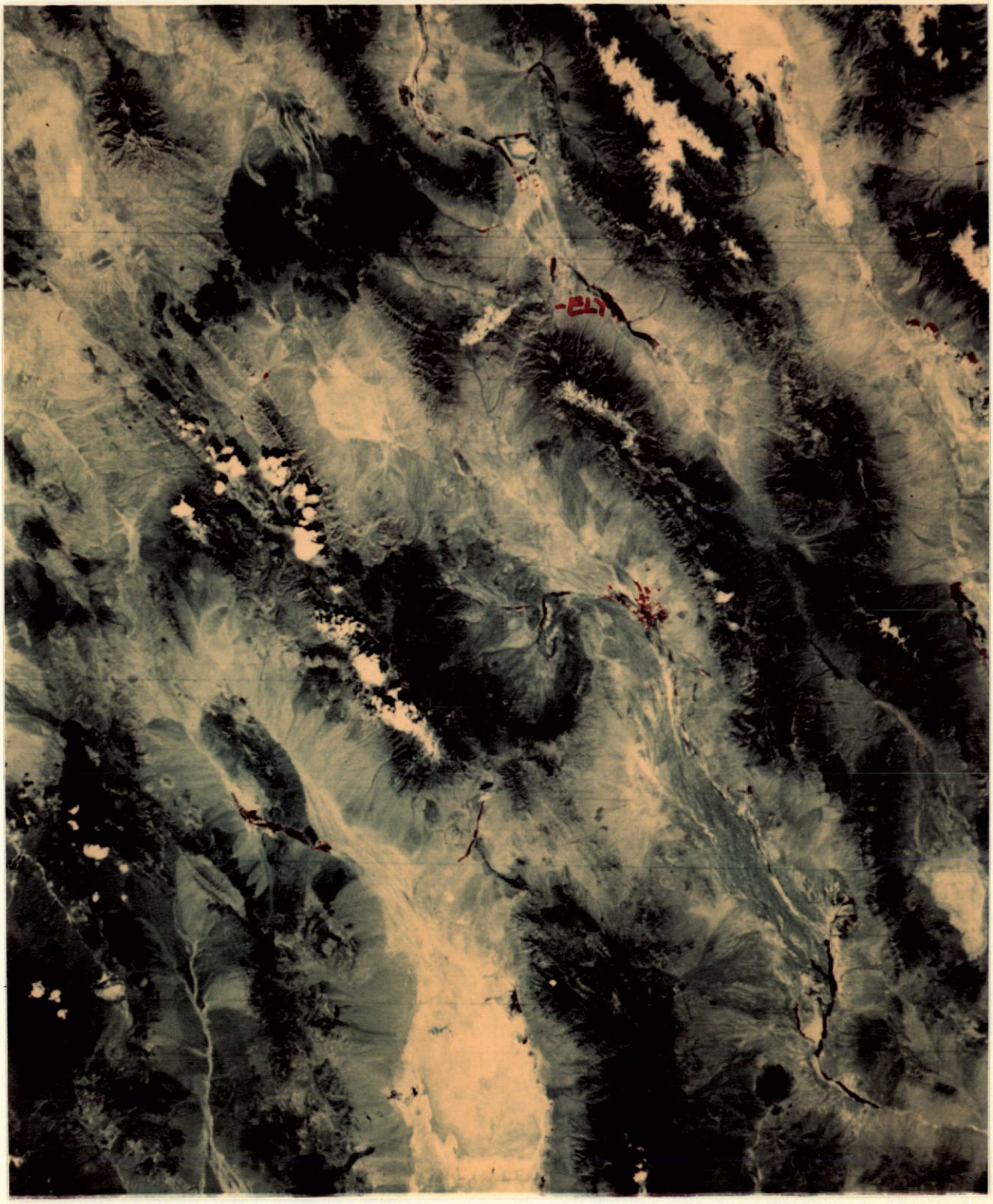
The area has been mapped in more detail and samples of mercury-bearing soil-gas have been collected within and outside the area.

The recent mapping and a 600 ft. drape aeromagnetic cover of the area indicates that the volcanics are not the sole cause of the anomalies. In addition Hg soil gas samples are highly anonymous given results in excess of 50 to 200 times background.



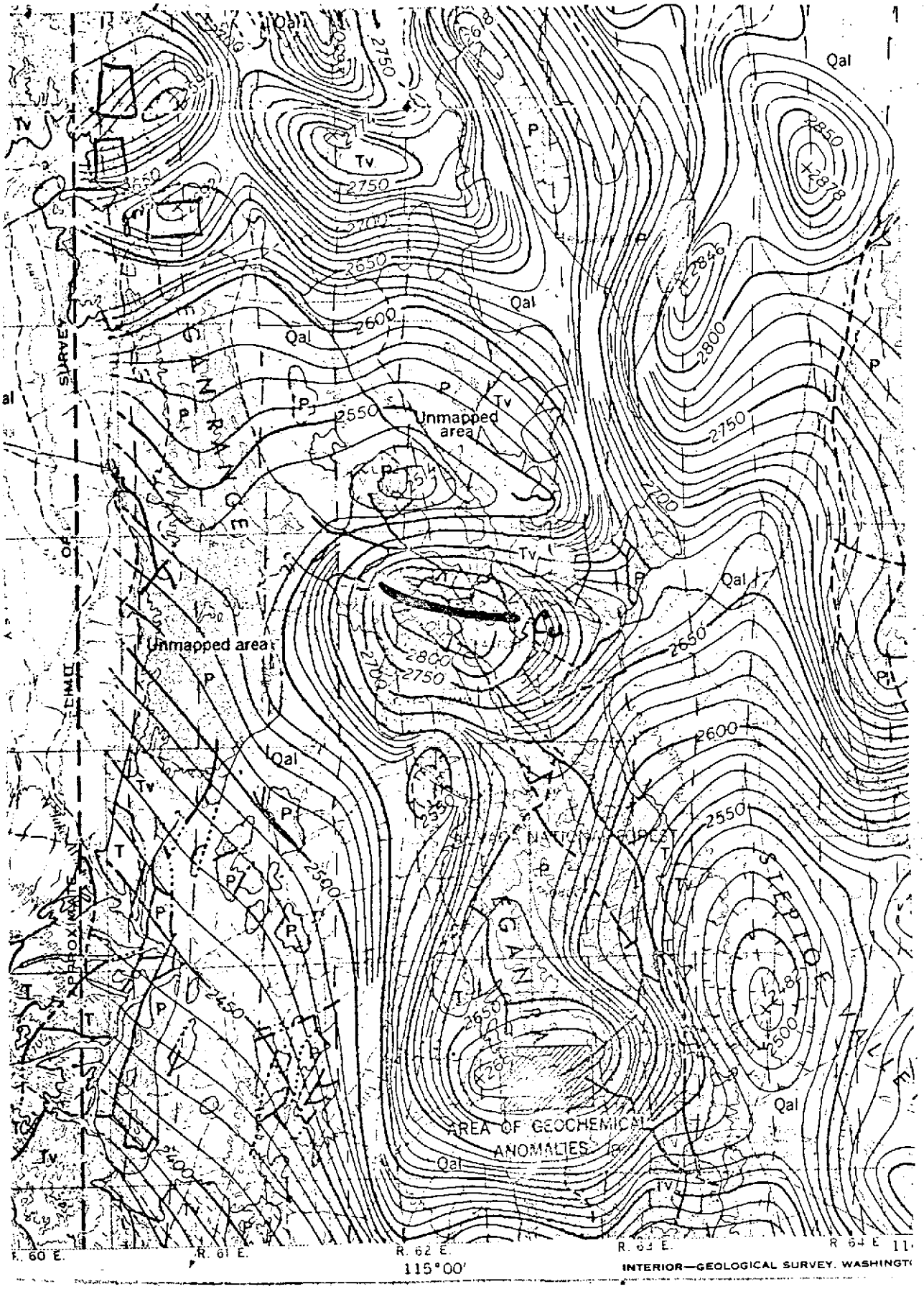
Robinson Mining District, White Pine County, Ely, Nevada
Scale: 1/728,000

The 70 mm positive transparencies is the source of this S-190A color photograph which was one of the first on which the light areas in the black Tr rocks located in the west corner of the image was detected. These light areas and others not evident on the photo are Permian limestone.



Robinson Mining District, White Pine County, Ely, Nevada
Scale: 1/728,000

This is an S-190A IR color image on which the details of the darker areas on the S-190A color photograph are more evident.



Total Intentisy Aeromagnetic Map
White Pine County, Nevada

From Carlson & Mabey
U.S.G.S., G.P. 392

This aeromagnetic map flown at 11,500 feet shows the three most positive aeromagnetic anomalies over Ward Mtn., Ruth, and the Tr area from south to north respectively. The 600 drape aeromagnetic map of the Tr area is, of course, much more detailed.

Robinson Mining District, White Pine County, Ely, Nevada
Scale: 1/250,000

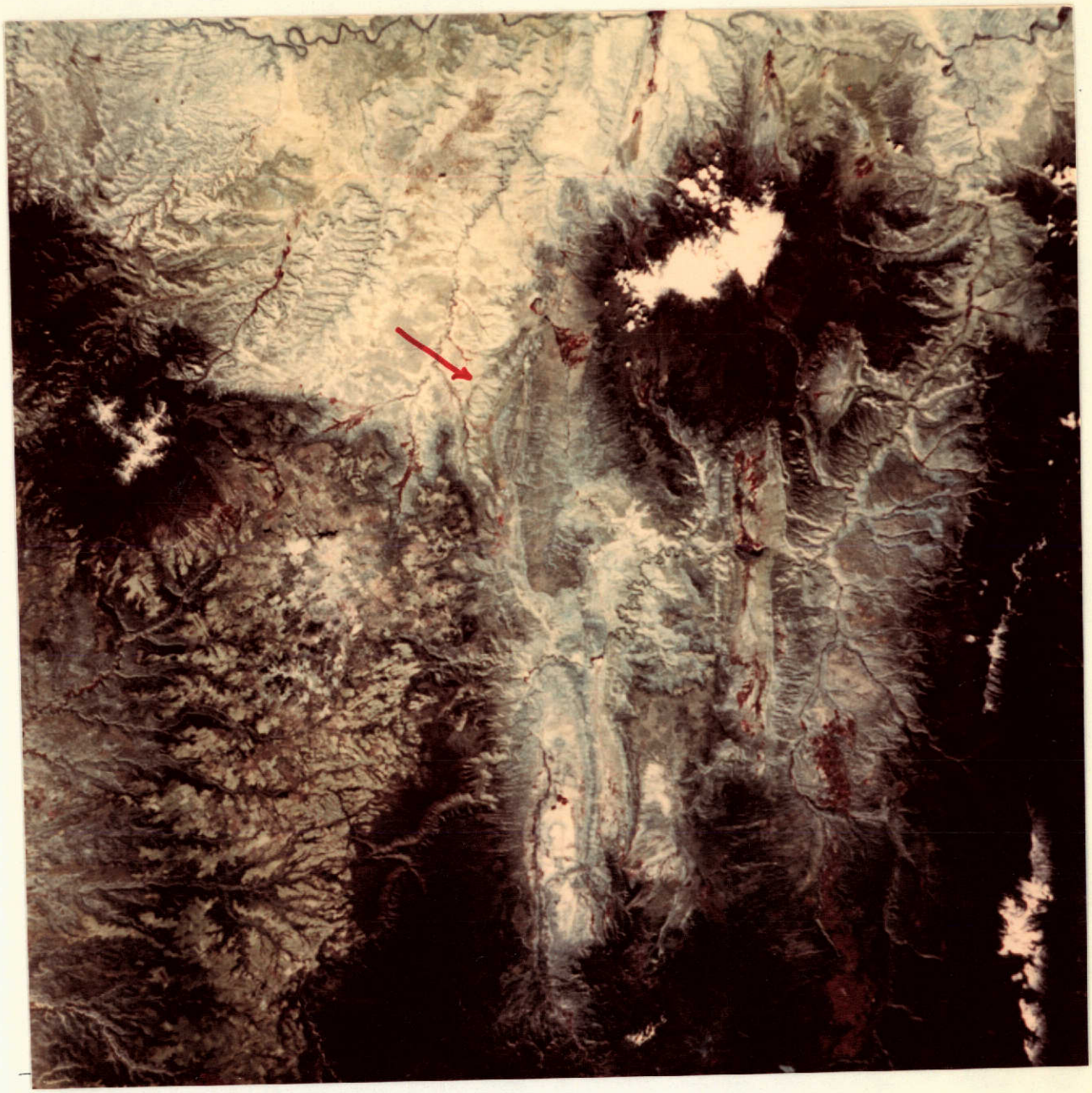
This is an ERTS-1 photograph that barely indludes the Tr area but it does show the comparison of the B&W image with coverage of EREP of the same area.

Robinson Mining District, White Pine County, Ely, Nevada
Scale: 1/250,000

This is a S-190A color enlargement of the volcanic area which, as the other images indicate, exhibits the east-west trend of the Ruth intrusive and pits but with the northwestern trend of Paleozoic rocks continuing under the Tr area.

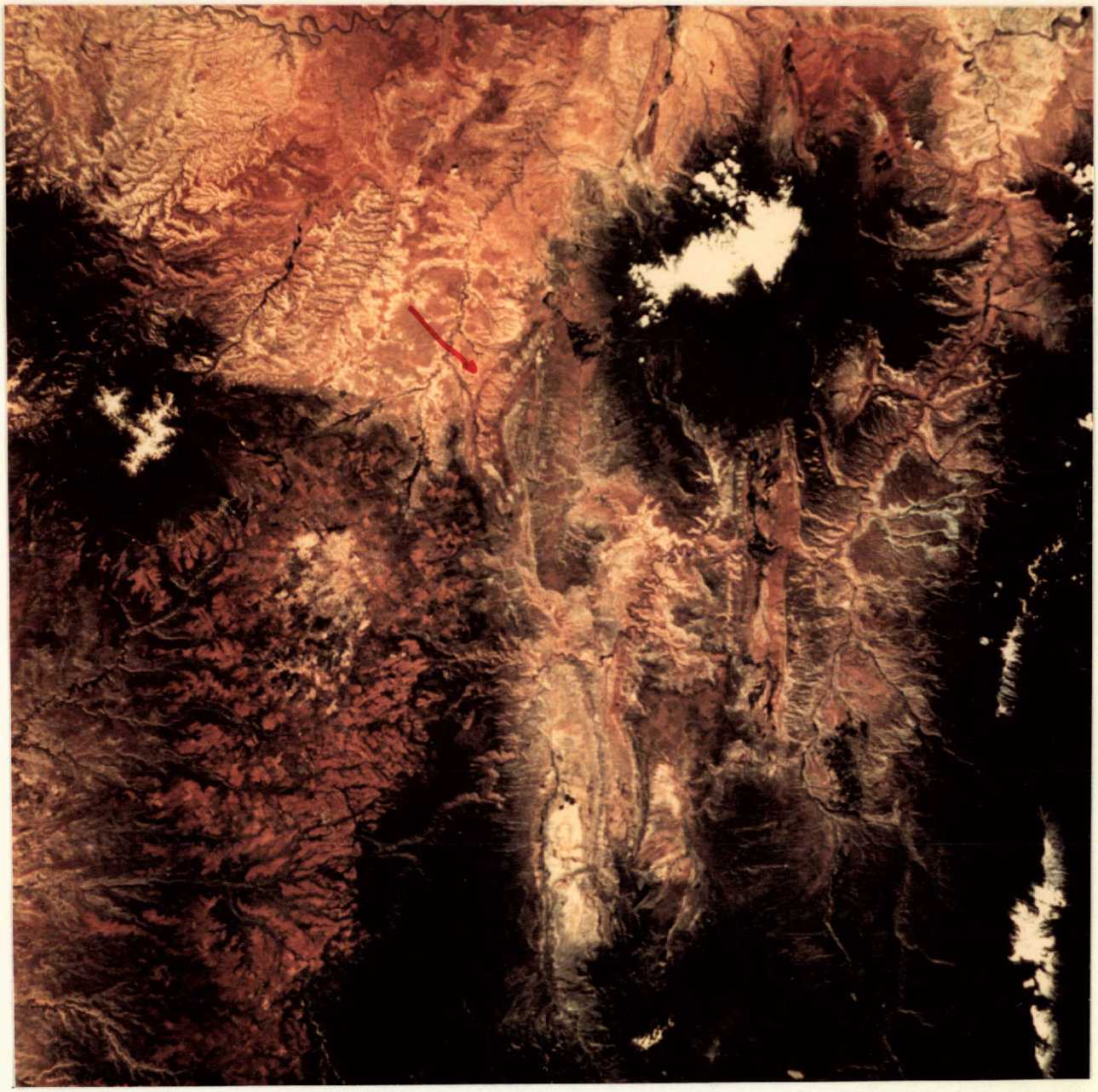
Robinson Mining District, White Pine County, Ely, Nevada
Scale: 1/250,000

This S-190A IR color photograph exhibits the same Tr outcrops as well as any image available. The Tr area is red color, of course, as this image which is the result of poorly radiating red of sagebrush and some Juniper trees. Note the waste dumps and poorly defined pits of the Ruth area at the bottom of the image.



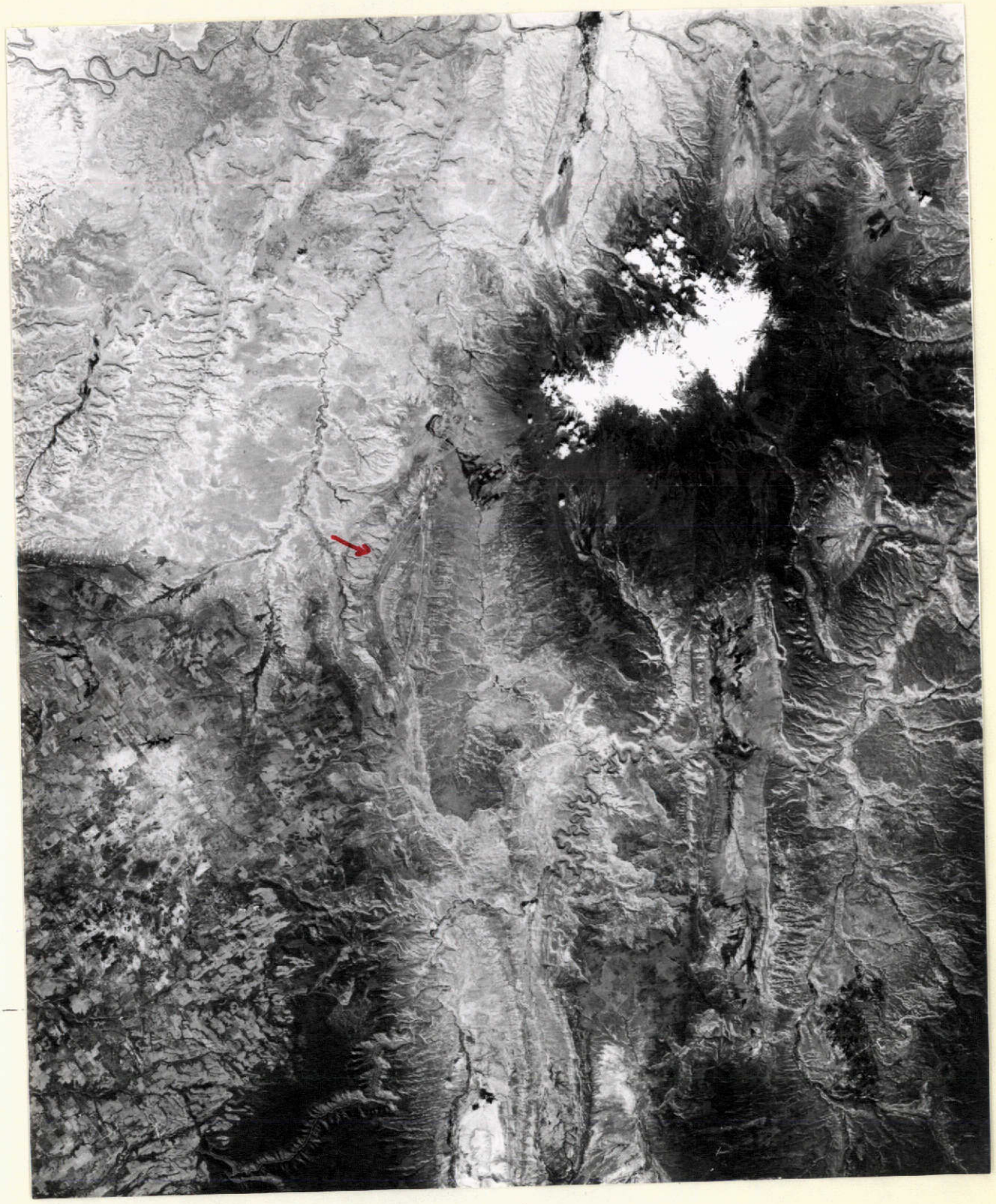
Lisbon Anticline, LaSal Mountains, and Abajo Mountains
Scale: 1/728,000

This is a S-190A IR color print where the intrusive bodies that form the mountains featured are cloud and snow covered but the Mesozoic sedimentary formation exhibit structures well, much better of course, on enlargements, or shown in subsequent maps. Arrow shows the Lisbon Anticline.



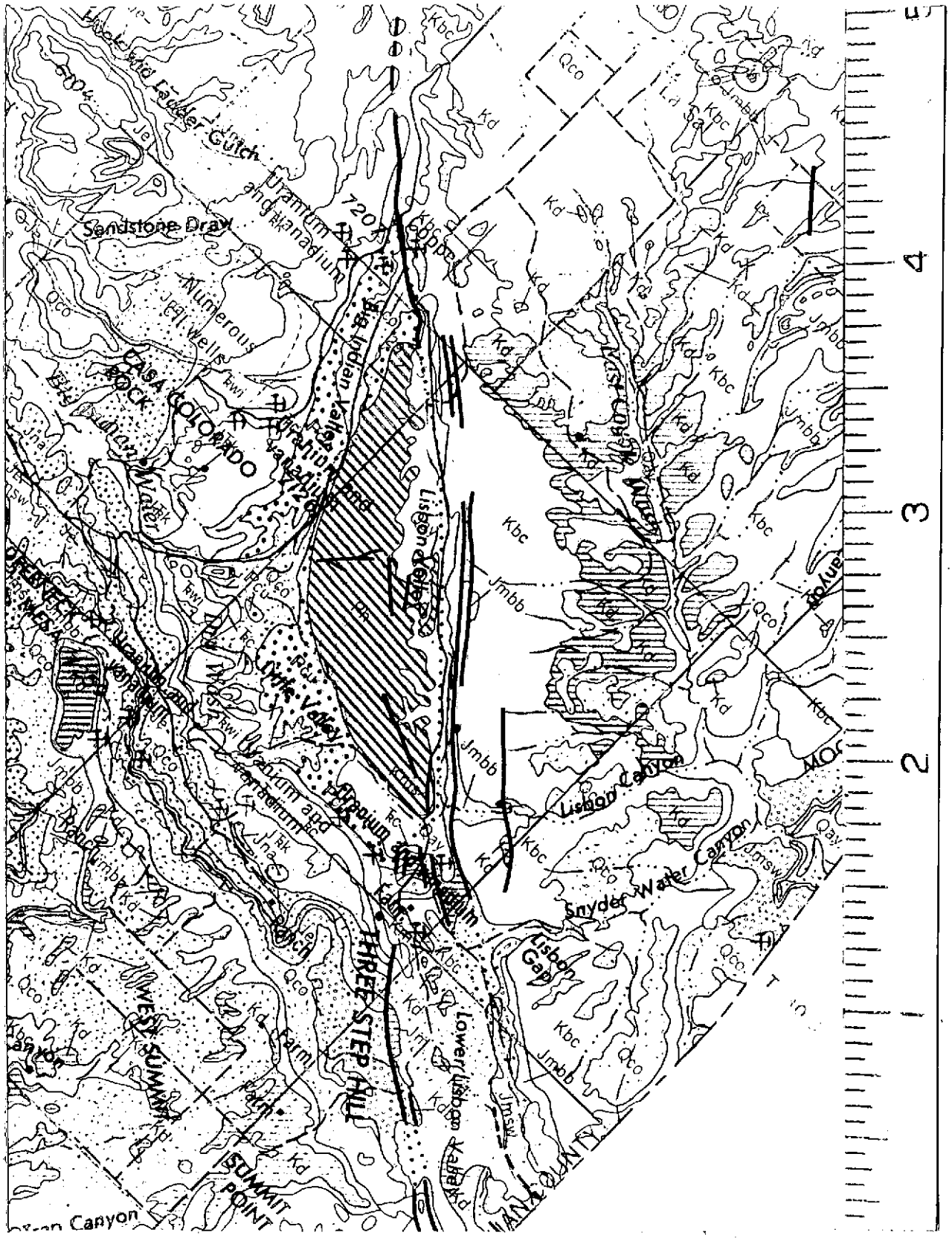
Lisbon Anticline, LaSal Mountains, and Abajo Mountains
Scale: 1/728,000

This S-190A color photograph is comparable to the color IR image enclosed. The flat lying sediments west of the Lisbon Anticline are, however, much more distinct on this image than on the IR image.



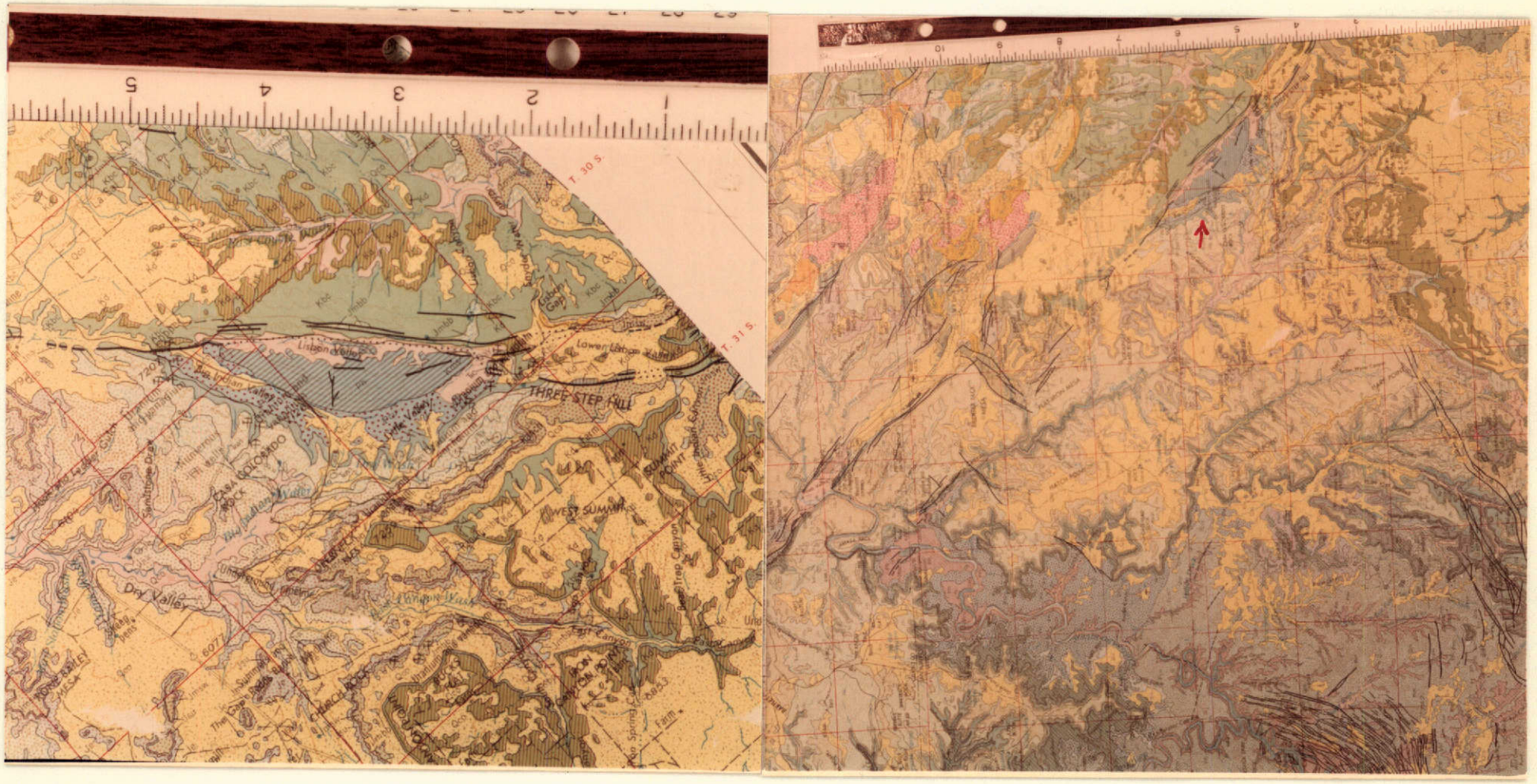
Lisbon Anticline, Grand County, Utah
Scale: 1/475,000

This S-190B B & W print exhibits the detailed features from which S-190B images are well known. The images withstand excellent enlargements as evidenced on the following image.



Lisbon Anticline, Grand County, Utah
Scale: 1/140,000

COLOR PRINTS OF PARTS OF STATE AND COUNTY GEOLOGIC MAPS COVERING DISTRICTS OF THIS REPORT.
ORIGINAL SCALE 1:250,000. NOTE RULER FOR PRINT SCALE.
LISBON ANTICLINE AREA



Part of S-190B photograph of Lisbon Anticline, Grand County, Utah
Scale: 1/150,000

Enlargement of S-190B B & W photograph. Note excellent correlation of faults from geologic map and their photographic evidence by abrupt lithologic changes on the eastern side of the Lisbon Anticline. The geologic formations on the west side of the gently dipping beds are easily mapped by the detail of this photograph.

Lisbon Anticline, Grand County, Utah
Scale: 1/120,000

This S-190A color photograph lacks the detail of S-190B and does not show the geologic Mesozoic Formations as well as S-190A and IR. Late Tertiary and Quaternary sediments, however, are more distinct on this image.

Lisbon Anticline, Grand County, Utah
Scale: 1/120,000

This S-190A IR color photograph can be compared to increased detail of the enclosed S-190B B & W photograph. The detection of geologic formations is more distinct, however, on this image because of the variagated color of Colorado Plateau sediments.